Introduction

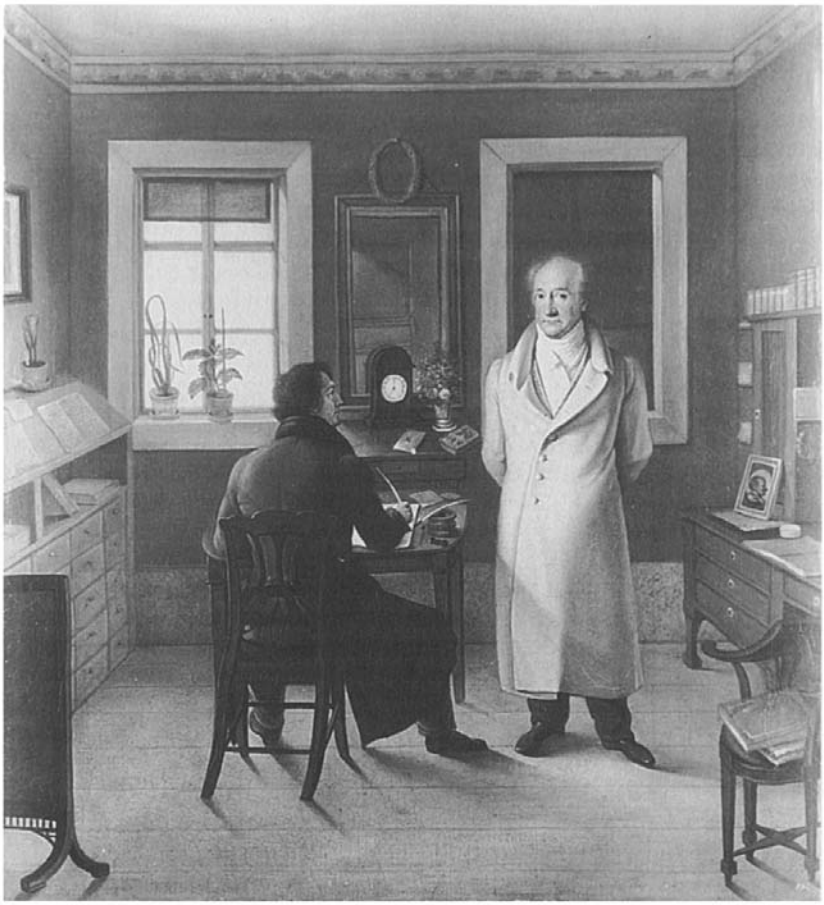
Johann Wolfgang Goethe was born on Aug. 28, 1749, in Frankfurt, an imperial city and coronation site for the emperors of the Holy Roman Empire of the German Nations. In 1774, following studies in law at the universities in Leipzig and Strasbourg, Goethe wrote *Die Leiden des jungen Werthers,* a novel in letter form about the pains of an unsuccessful love affair and the anxieties of a young man seeking his place in German society. In other works from the early 1770s, Goethe discovered his Germanic roots, writing a play about *Götz von Berlichingen,* a minor political figure of the Martin Luther era, folk poems such as "Heidenröslein," and essays on Shakespeare and Gothic architecture. At the age of twenty-five, Goethe's literary success prompted an invitation from Duke Karl August to visit the small duchy of Saxony–Weimar. Here he stayed, soon becoming an administrator in the economic, political, social, and cultural affairs of the state.[1] Poet, scientist, and thinker, Goethe became Germany's most famous writer, internationally known for the breadth of his knowledge and the universality of his genius.[2]

Goethe was a prolific writer, ranging in forms of expression from the essay for his research in geology, comparative anatomy, botany, and color theory; to dramas about human rights, political intrigue, and wars; and novels about marriage and the development of the artist.[3] He is best known for the richness of his poetic verse, which includes some of the finest lyrics in the German language, as in the poems "Mailied," "Wanders Nachtlied," and "Der König in Thule." Many of his intellectual and personal experiences are woven together in his most famous work, *Faust,* begun in the restless period of his youth and completed a year before he died. This dramatic poem of 12,111 lines was written in two parts, the first focused on the life of the adventurer and magician in the small world of love and learning, and the second on the way he engaged the broader forces of science, politics, and culture. In both parts the hero was seeking ultimate knowledge about life and nature, a vision of modern scientific man that Goethe shared during the 1790s with friends and colleagues at the Friday Round Table discussions held in the Wittumspalais of Duchess Anna Amalia.

A watercolor of the "Round Table" (Tafelrunde), a Friday discussion group sponsored by Duchess Anna Amalia of Weimar–Saxony at the Wittumspalais in Weimar. Duchess Amalia is seated at the center behind the table and Goethe is seated to her right at the end of the table, partly hidden from view by a colleague to his right. Painted by Georg M. Kraus about 1795. From the Nationale Forschungs- und Gedenkstätten, Weimar.

Goethe traveled extensively, but left Weimar only once for an extended period, 1786–8, which he spent in Italy in study of classical art and literature. In the two decades, 1790–1810, relieved of many of his administrative duties, he devoted much of his time to studying the history of science and doing research on plant morphology and color theory, and at the same time writing classical German verse. And in 1809 he published *Die Wahlverwandtschaften,* a novel about marriage cloaked in the symbolism of the language of chemistry.

During the last two decades of his life, he continued these parallel interests in the arts and sciences, in both dimensions reflecting on the processes that move the creative spirit of the human being. In these decades he began his autobiographical writings, completed the stories of Wilhelm Meister, the hero of the artist's drive to shape life, and Faust, the hero of the modern drive to know all of life. Between 1810 and 1820, the synthesis of these urges drove him to study oriental literature, resulting in a collection of critical essays and in a cycle of love poems, the *West–östlicher Divan.* This blend of Eastern and Western themes, stimulated by one of many close relationships with a woman, put a global stamp on his life and works. Goethe, the author of the concept of



An oil painting of Goethe in his study, dictating to his scribe, John, by Johann J. Schmeller, 1829–31. From the Nationale Forschungs- und Gedenkstätten, Weimar.

world literature, continued writing into the last years of his life, in his study living the legend of the Faustian quest for knowledge.

When he died on March 22, 1832, Goethe left posterity a collected edition of forty volumes edited in his own hand (1827–30), with instructions for the posthumous publication of twenty additional volumes (1832–42). He also left an archive of unpublished notes and manuscripts, a museum of scientific instruments, works of art, cabinets of flora, fauna, and minerals, and a personal library of over five thousand books. And from this depository, heirs of Western culture have shaped their concept of his effects, ranging in approach from new scholarly editions of his writings, to displays of artifacts in muse-

ums, to audiovisual versions of his works, indeed, to the dramatization of his way of life.[4]

Even though Goethe left few technical marks on the pages of modern science, scholars, scientists, artists, and students remain fascinated by his nature studies. By 1940 this fascination had generated the 4,500 items listed in Günther Schmid's bibliography, and by the estimation of one of the leading critics of Goethe's science, Dorothea Kuhn, "the 5000th title has probably long since been passed."[5] Also adding to the interest in Goethe's scientific work is a collection of over 50,000 artifacts on nature and culture, a small museum of scientific instruments from his era,[6] and well over a dozen volumes of published and archival writings on scientific topics.

For the scholar and critic, study of the scope and richness of these writings is challenging and intriguing, for at least half of his collected volumes consists of unpublished research notes, letters, diary comments, book reviews, and sketches and outlines he wrote in preparation of his published works. From these published and unpublished materials the critic has the opportunity to study Goethe's science in the context it took shape, adding social and biographical background to examination of the scientific text. Until recently this holistic approach to the study of Goethe's science would have been a very tedious affair, for it would have required work with the cumbersome Weimar edition (WA) and with various other isolated resources, such as with the collections of his letters.

After 1947 the fragmented picture of Goethe's scientific writings began to change with the regular publication of new volumes of his works in the Leopoldina edition (LA). The edition was planned in two parts, the first including Goethe's primary writings, published and unpublished, and the second comprising contextual materials that contain the biographical and archival background to his scientific work.[7] It is the more recent appearance of the volumes in Part II, the first two in 1959 and 1961 and the other three in 1973, 1977, and 1986, that has made less tedious the task of examining Goethe's scientific writings as a whole. It is also easier to work with this new edition because it has been organized chronologically and topically, beginning with two volumes on his studies in mineralogy and geology. Volumes three to seven are devoted to his work in color theory, while eight and nine are published notebooks, one on science in general and another on morphology. The last two volumes repeat this separation, each focusing on fragments and essays not published elsewhere in the edition. Thus, in each field of inquiry the reader can follow Goethe's development as writer, thinker, and scientist, roughly from age twenty-one to eighty-two.

The present study of Goethe's historiography of science is focused on volume six of the Leopoldina edition, on the *Materialien zur Geschichte der Farbenlehre,* although discussion in the early chapters is based on materials from the entire collection of his scientific writings. Much of this material is

considered primary, although it comprises many pages never published in Goethe's lifetime, materials printed in recent years as a convenience to the scholarly world. This editorial approach has opened the doors to new examinations of Goethe as a scientist,[8] and to his views on the history of science, a field that matured with Goethe's interest in science in general and in color and optics in specific. But the picture is still broader than the writings contained in the Leopoldina edition, for to these one must relate the poetry and prose of his imaginative writings, which also comprise views on nature, science, and the history of science.

A look at the entire spectrum of Goethe's writings on science brings several perspectives to our understanding of his theory of the history of science, including the fact that in most of his nature studies he tended to review the history of the problem on which he was working. Secondly, there are certain views from his approach to science that also conditioned his estimation of documents in the history of science. These views are embedded in his science, and understanding them gives us some insight into the development of his theory of the history of science. And finally, a look at the entire range of his nature studies, including primary and secondary, published and unpublished works, provides a basis for examining Goethe as a scientific writer, a point of view important to his history of science, for he, too, based his view of scientists from the past on the documents they left posterity.

Part I

The real joints of nature

> Basic characteristic of an individual organism: to divide, to unite, to merge into the universal, to abide in the particular, to transform itself, to define itself, and as living things tend to appear under a thousand conditions, to arise and vanish, to solidify and melt, to freeze and flow, to expand and contract. Since these effects occur together, any or all may occur at the same moment.[1]

1

Goethe's romantic science

When Goethe matriculated at the University of Strasbourg in 1770, he enrolled in a liberal arts curriculum with courses in political science, history, anatomy, surgery, and chemistry. He had planned a doctorate in law, following his father's wishes, but only achieved the "licentiate" to practice law. He had written a dissertation on "The Legislature, On the Power of the Magistrate to Determine Religion and Culture" (De legislatoribus, über die Macht der Gesetzgeber, über Religion und Kultus zu bestimmen), but it was an attack on orthodoxy and the thesis was rejected.[2] The thesis itself is not extant, but from a letter written by one of his professors, we learn that, among other controversial assertions, Goethe contended that "Jesus Christ was not the author of our religion, but that a number of other wise men composed it in his name. The Christian religion, he avers, is merely a rational, political institution."[3] The episode is not atypical for the annals of higher education, but in Goethe's case is significant, because in it we find early evidence of the exception he took to tradition, apparently "puffed up over his store of knowledge, but chiefly by reason of a few undesirable traits he has got from M. Voltaire."[4]

Following the rejection of the dissertation, Goethe showed his contempt for the authorities of the university by offering a series of theses for disputation, fifty-six in all, some thought extremely simplistic, others conservative, and still others liberal and progressive, collectively written without logical order.[5] But from this list of disputations, we see questions about life that were to fall within the pale of his literary and scientific works during the next sixty years. In the first thesis, for example, in the one considered simplistic by the law faculty, he proposed that "natural law is what nature has taught all creatures" (Jus naturae est, quod natura omnia animalia docuit, WA, I, 37, 119), a statement that bore the seeds of his romantic science, which said that the lessons of life can be found in nature itself, that science should interpret nature, not serve technology.[6] From this perspective he asked in disputation fifty-five about the rights and responsibilities of a mother in childbirth, raising an issue that was to emerge later in his Faust story: "Should the woman who kills her newly born child suffer the death penalty? There is no unity among

the learned on this point" (An foemina partum recenter editum trucidans capite plectenda fit? quaestio est inter Doctores controversa, p. 125).

The red thread running through his formal educational experience was shaped by questions about human nature, about the rights of individuals and states, about patterns of life and death. With these questions Goethe gave vent to his distaste for learned authority, casting about for new ways of looking at the relationship of human beings to nature, society, and tradition, challenging a world order that had become dated.[7] And in this quest he drew inspiration from a small circle of friends in Strasbourg that gave birth to the movement that became known as the German Storm and Stress, a movement considered by some an analogue to the French Revolution.[8] These emergent writers set a course for the revival of science and literature in Germany, a course grounded in the quest for a science of human beings, for study of their nature, culture and history. By the end of the decade, Friedrich Schiller (1759–1805) repeated Goethe's search for new definitions of human nature when he succeeded in writing a dissertation "On The Relationship of Man's animal and spiritual Nature" (Ueber den Zusammenhang der tierischen Natur des Menschen mit seiner geistigen).[9] Here Schiller, after having his first dissertation on a philosophy of physiology rejected, found a thesis that captured the central issue of Storm and Stress anthropology.

By 1771 Johann G. Herder (1744–1803), Goethe's mentor and the intellectual leader of the Storm and Stress movement, had completed his "Treatise on the Origins of Language," arguing that language developed from within the human being, disputing the view of some that it was God-given and of others that it was animal imitation.[10] Then in 1774 he further challenged intellectual orthodoxy with "Another Philosophy of History for the Formation of Mankind," initiating ideas that brought about the demise of divine providence in interpretation of the history and origin of peoples of the globe.[11] In this effort, Herder was arguing for a new kind of historiography, one grounded in a teleology of cultural forms, like other participants in the Storm and Stress decade, introducing ideas that would emerge in the next decades as mature statements, as finished versions of earlier notions.

Immanuel Kant (1724–1804), Herder's teacher at the University of Königsberg, also set the parameters for the fields of Goethe's interest. He began his lectures on anthropology in the Winter Semester of 1772–3, by the middle of the decade announcing his traditional course on physical geography with an essay "On the Different Races of Mankind."[12] Here Kant argued that the races of mankind were of a single species, a definition he grounded in the "Buffon test" (Büffonsche Regel),[13] which said that animals that mate and produce fertile offspring belong to the same species. With this essay Kant introduced a biological connection between man and animal, in the same year that Johann Blumenbach (1752–1840) completed his dissertation "On the Natural Varieties of Mankind" (1775), dividing the peoples of the globe into

four groups, the Americans, Caucasians, Mongolians, and Ethiopians.[14] With Kant, he argued the unity of the human species according to the "Buffon test" and, while both agreed that this test confirmed the blood relationship of all peoples of the globe, they also understood that this relationship neither explained the diversity nor the origins of the various peoples of the globe. This question remained open, surfacing again in the middle of the next decade when Goethe began research in human and animal anatomy.

By 1775, the first steps had been taken toward a unified theory of anthropology grounded in teleology of organic forms, by Herder in history and Kant and Blumenbach in biology. Together they confronted popularized versions of Linnean anthropology, as found, for example, in Voltaire's (1694–1778) *Philosophy of History* (1765), in which he argued that "none but the blind can doubt that the whites, the negroes, the Albinoes, the Hottentots, the Laplanders, the Chinese, the Americans, are races entirely different."[15] Others in the Storm and Stress decade (1770–80), like Georg Forster (1754–94), participated in the search for new definitions of the peoples of the globe, but none so systematically documented the myths behind racial prejudices and so convincingly argued for the unity of the human species as did Blumenbach in his dissertation on the varieties of peoples of the globe. And in the years that followed, he continued to improve this definition, by 1779 assimilating the new ethnographic materials on Polynesian cultures into his famous theory of the five races of mankind. Then, in 1781, he published his second major contribution to the biology of the human being, his theory of the "forces of formation" (Bildungstrieb).[16]

These developments in physical anthropology entered Goethe's writings in science early in the next decade. In 1775 he had taken an appointment in the administration of the small duchy of Saxony-Weimar, beginning a career at first limited to cultural affairs, but one that soon required research for decisions on mining, engineering, economics, education, and financial management. In 1776 he brought Herder to Weimar to serve as general superintendent of education, thus, staying in touch with the emerging author of historical teleology and cultural pluralism. By 1783 he met Blumenbach in Weimar, remaining in close contact with him the rest of his life, joining him and Kant in the search for definitions of the human being.[17]

In a series of short essays, "On Morphology" (1817–22), Goethe recalled the way developments in physical anthropology entered his intellectual framework, emphasizing particularly the influence of Kant's "teleology of judgment" (teleologische Urteilskraft, p. 92) and Blumenbach's "theory of epigenesis" (Theorie der Epigenesis, p. 99).[18] In these essays Goethe expressed appreciation for Blumenbach's energized versions of organic development (Bildungstrieb), but also explained that he viewed the concept of "force" (Kraft), and particularly "drive" (Trieb), as highly anthropomorphized. In his view, these terms assume something "physical" (physisch) and "mechani-

cal" (mechanisch), and while they bring vitality to organized matter, they still leave us with a gap in the understanding of organic development, with "a dark incomprehensible point" (ein dunkler unbegreiflicher Punkt). Nor were terms like "evolution" (Evolution), "epigenesis" (Epigenese), and "preformation" (Präformation) of any help. These, too, he argued, could not be understood without a concept of forms in process, of "metamorphosis" (Metamorphose), the science that emerged from the first phase of Goethe's struggles with the way of nature.[19]

In defense of nature's unity

An incision into Goethe's topography of nature begins at that point when he began to articulate a detached view of his relationship to his environment, or at least when he began to recognize that it was possible to write about nature in an intimate or detached manner. These beginnings can be found in his poetic writings, as in the poem "Maysong" (Mailied), written in 1771 during the Storm and Stress period of literary and cultural revival in Germany.[20] This celebration of nature in the month of May is on the surface a light song of nine stanzas, each one advancing toward the center, where the infatuation with nature is supplanted by that for his "sweetheart" (Mädchen, p. 12). This symmetry in structure corresponds to the thematic balance of the poem. In the first four stanzas Goethe sings to the joys of nature, and in the fifth he signals a transition in the celebration from nature to lover, the focus of the closing four stanzas.

The point, in this introduction to Goethe's maturing views as a scientist, is that even in his earliest poems Goethe recognized a subject–object relationship in writing about nature. Most importantly he recognized that the relationship could be turned off and on, that there is a threshold between the author's feelings for nature and the thoughts springing from them. Indeed, a transition stanza in the poem marks the border between the two topics, but also unites them with a personal pronoun, "you" (Du), which refers back to nature and forward to his sweetheart. Passion and intimacy underscore the relationship to nature and to lover, but in this particular poem, feelings for nature precede, or maybe even are the source of those for the lover, at least so it would appear, based on the sequence presented in the written form.

The author–nature, or the subject–object relationship, and a clearly marked transition is again central to the structural symmetry of the poem "On the Lake" (Auf dem See) from 1775, a poem written shortly before he began his professional career in the administration of Duke Karl August in Weimar.[21] Here the middle stanza marks the transition from the author's feelings for nature to a detached description of a scene on a lake in Switzerland. Indeed, here Goethe makes the transition experience the central message of the poem.