

## *Hypatia (370-415)*

During the pre-Christian era, the philosophical schools of Plato and Pythagoras created a favorable social climate for women to be able to pursue an academic career. Although there were many women who were well educated in Greek mathematics, Hypatia was the first woman in mathematics of whom we have considerable knowledge. Despite her legendary talents, her beauty, her long life of hard work, and her celebrated accomplishments in mathematics and astronomy, the story of her eventual martyrdom excites almost the same sympathies as a classic Greek tragedy.

Hypatia was born around 370 A.D. (Hoche notes that following the *Suda Lexicon s.v. Damascius*, we might assume that 375 is the correct date), and was given a very thorough education in mathematics and philosophy by her father, Theon. Theon was a distinguished professor of mathematics and later the director of the University of Alexandria. Theon was determined to produce a perfect human being. From her earliest years Hypatia was immersed in an atmosphere of learning, questioning, and exploring, and spending much time at the institute called the *Museum*. Fourth century Alexandria was the western world's center of scientific, philosophic, and other intellectual development; it was a cosmopolitan center where scholars from all the civilized countries gathered to exchange ideas. As Theon's daughter, Hypatia was a part of this stimulating and challenging environment and received very thorough formal training in arts, literature, science, and philosophy. Theon was his daughter's tutor, teacher, and playmate; his own strong love of the beauty and logic of mathematics was contagious. He was influential in this part of Hypatia's intellectual development, which was eventually to eclipse his own.

Hypatia lived during paganism's last stand against the encroaching Christian religion and in a sense personally represented the conflict between pagan Greek science, philosophy, and mathematics, on the one hand, and the Christian religious and political empire on the other. Scientific neo-Platonism was flourishing when Hypatia was born. Since Hypatia was known to have taught philosophy in Alexandria, it is natural to assume that her training in philosophy was received from philosophers of the neo-Platonic school at Alexandria. At the time, mathematics was used mainly for calculating obscure problems such as the locus of a given soul born under a certain planet. It was thought that mathematical calculations could determine precisely where such a soul would be on a future date. Astronomy and astrology were considered as one science and mathematics was a bond between this science and religion. These disciplines were a part of Hypatia's early training. Furthermore, Theon introduced her to all the systems of religion known to that part of the civilized world; he was determined to transmit to Hypatia not only the accumulated fund of knowledge but the ability to discriminate in order to assimilate and build upon this fund. Toward this end, he was particularly concerned that she be discriminant about religion and that no rigid belief take possession of her life to the exclusion of new truths. "All formal dogmatic religions are fallacious and must never be accepted by

self-respecting persons as final," he told her. "Reserve your right to think, for even to think wrongly is better than not to think at all."

As part of the preparation for becoming the "perfect human being", Theon also established a regimen of physical training to ensure that Hypatia's healthy body would match her formidable, swift, well-trained mind. He devised a series of calisthenics for her daily exercises in addition to teaching her to swim, ride horseback, and climb mountains. Furthermore, Hypatia was given formal training in speech, lessons in rhetoric, the power of words, the power of hypnotic suggestion, and the proper use of her voice. To further her education, Hypatia traveled abroad and was at one time a student in Athens at the school conducted by Plutarch the Younger and his daughter Asclepigenia. It was here that her fame as a mathematician became established and eventually led to the invitation by the magistrates of Alexandria to teach mathematics and philosophy at the university.

Her appointment came near the year 400 when she was twenty-five or thirty years old. Since women were not routinely elected to paid public office, her appointment must have been a unique and exceptional honor. The uniqueness of Hypatia's position appears even more significant when we consider the fact that the government of Alexandria was Christian and Hypatia was a pagan. She accepted this invitation and spent the last part of her life teaching at the university of Alexandria. Socrates, the historian, wrote that her home (as well as her lecture room), was frequented by the most unrelenting scholars of the day, and was one of the most compelling intellectual centers in Alexandria. She was considered an oracle;enthusiastic students from Europe, Asia, and Africa came to hear her lecture on the *Arithmetica* of Diophantus, the techniques that Diophantus had developed, his solutions of indeterminate problems of various types, and the symbolism he had devised. Hypatia's teaching activities comes from a number of sources, including some of her most famous students. According to Damascius, she taught geometry and mathematics. Philostorgius tells us that she excelled her father Theon in mathematics-and Theon was the Museum's most famous mathematician. Hesychius tells us that she was an excellent astronomer-as was her father.

Hypatia was the author of several treatises on mathematics. Suidas, the late-tenth-century lexicographer of Greek writings, listed several titles attributed to her. Most were destroyed along with the Ptolemaic libraries in Alexandria or when the temple of Serapis was sacked by a mob, and only fragments of her work remain. There is convincing evidence that her *Commentary on Diophantus' Arithmeticonum* has survived, interpolated in part into the original text. A portion of her original treatise *On the Astronomical Canon of Diophantus* was found during the fifteenth century in the Vatican library;it was most likely taken there after Constantinople had fallen to the Turks. Diophantine algebra dealt with first-degree and quadratic equations; the commentaries by Hypatia include some alternative solutions and a number of new problems that she originated.

In addition to these works, Hypatia also wrote *On the Conics of Apollonius*, popularizing his text. With the close of the Greek period, interest in conic sections waned. After Hypatia, these curves were largely neglected by mathematicians until the first half of the seventeenth century. Hypatia also wrote commentaries on the *Almagest*, the astronomical canon of Ptolemy's that contained his numerous observations of the stars. Furthermore, she coauthored (with her father) at least one treatise on Euclid. Most of these works are prepared as textbooks for her students. As was the case with her commentaries on Conics, no further progress was made in mathematical science as taught by Hypatia until the work of Descartes, Newton, and Leibniz many centuries later.

Among Hypatia's most distinguished pupils was the eminent philosopher Synesius of Cyrene, who was later to become the wealthy and influential Bishop of Ptolemais. Synesius was almost exclusively educated by Hypatia. He wrote that Hypatia taught the works of Plato, Aristotle, as well as neo-Platonism and its "mysteries", astronomy, mechanics, and mathematics.. Synesius learned Plotinian neo-Platonism, "pagan" religious philosophy somewhat opposed to Christian philosophy, from Hypatia. This philosophy formed an integral part of the intellectual transition from pagan Greek philosophy to Christianity. It was Synesius' study of Plotinus under Hypatia that caused Synesius to become a Christian and later a bishop of the Church at Ptolemais. In Synesius' letters, Hypatia was not only viewed as the greatest then-living exponent of Platonic and Aristotelian philosophy, neo-Platonism, and mathematics, but her students came from afar to study under her. When Synesius went to Alexandria to study under Hypatia, the emperor Theodosius forbade pagan cult practices in Egypt, and there was widespread turmoil and rioting between pagans and Christians. In his work, *Dion*, Synesius speaks in defense of the neo-Platonism taught by Hypatia. In its mixture of mysticism and cynicism, God is not only supreme, but One, and unknowable in any direct way by man. Matter is evil and Nous is holy. But since man is partly material and part spiritual/rational, man is part evil, part holy. Through self-discipline and a cynic subjugation of the senses man can become capable of receiving direct revelation of divine truth from the universal Nous. This philosophy of religion/epistemology espoused by Hypatia and Synesius was clearly compatible both with Hypatia's paganism and with Synesius' Christianity.

Synesius' letters asking for scientific advice have furnished us with one of the richest sources of information concerning Hypatia and her works. His letters credited Hypatia with the invention of an astrolabe and a planesphere, both devices designed for studying astronomy. His letters also credited her with the invention of an apparatus for distilling water, one for measuring the level of water, and a third for determining the specific gravity of liquids. This latter device was called an aerometer or hydroscope.

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Hypatia's contemporaries wrote almost lyrically about her great genius. Socrates, Nicephorus, and Philostorgius, all ecclesiastical historians of a persuasion different from that of Hypatia, nevertheless were generous in their praise of her characteristics and learning. Her popularity was wide and genuine. She may have had several offers of marriage from princes and philosophers, but to these proposals she answered that she was "wedded to the truth." It is more likely that she simply never met a suitor whose mind and philosophy matched her own. Although she never married, she did have love affairs.

Since Hypatia belonged to a neo-Platonic Greek school of thought (the scientific rationalism of this school ran counter to the doctrinaire beliefs of the dominant Christian religion, seriously threatening the Christian leaders. These pieties considered Hypatia's philosophy heretical, and when Cyril became patriarch of Alexandria in 412 A. D., he began a systematic program of oppression against such heretics. Because of her beliefs and her friendship with Orestes, the prefect of Egypt, whose influence represented the only countervailing force against Cyril, Hypatia was caught as a pawn in the political reprisals between the two factions. Cyril was an effective inquisitor. He began by inflaming the passions of the populace, setting mobs on his detractors. At his direction, a mob of religious fanatics set upon Hypatia, dragging her from her chariot while she was on her way to classes at the university, pulling out all of her hair, and subsequently torturing her to death. Orestes felt a responsibility for Hypatia's cruel death and did what he could to bring the culprits to justice. He reported her death to Rome and asked for an investigation. Then fearing for his own life, he quit the city. The investigation was repeatedly postponed for "lack of witnesses," and finally it was given out by the Bishop that Hypatia was in Athens and there had been no tragedy. Orestes' successor was forced to cooperate with the Bishop, and as one historian phrased it, "Dogmatism as a police system was supreme".

Hypatia's place in history seems relatively secure. Often she is the only woman mentioned in mathematical histories. Her life and times have been romanticized by Charles Kingsley in his book *Hypatia: Foes with an Old Face*. But this novel almost completely ignored Hypatia's significant work in mathematics. Mozans on the other hand, gives more emphasis to Hypatia's place in science; he writes that she was

Among the women of antiquity what Sappho was in poetry and what Aspasia was in philosophy and eloquence—the chiefest glory of her sex. In profundity of knowledge and variety of attainments she had few peers among her contemporaries and she is entitled to a conspicuous place among such luminaries of science as Ptolemy, Euclid, Apollonius, Diophantus and Hipparchus.

He also regrets that this "favored daughter of the Muses" is absent from Raphael's painting *School of Athens* and attributed this omission to the fact that her achievements were not as well known in Raphael's day as they are presently. Whether Raphael's ignorance, his close relationship with the Church, or his own provincialism caused the slight, it was a phenomenon similar to that which many other women in mathematics were to experience.