

## Theon of Alexandria and Hypatia

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ABSTRACT. In this paper we present the story of the most famous ancient female mathematician, Hypatia, and her father Theon of Alexandria.

The mathematician and philosopher Hypatia flourished in Alexandria from the second part of the 4<sup>th</sup> century until her violent death incurred by a mob in 415. She was the daughter of Theon of Alexandria, a mathematician and astronomer, who flourished in Alexandria during the second part of the fourth century. Information on Theon's life is only brief, coming mainly from a note in the Suda (Suida's Lexicon, written about 1000 AD) stating that he lived in Alexandria in the times of Theodosius I (who reigned AD 379-395) and taught at the Museum.

He is, in fact, the Museum's last attested member. Descriptions of two eclipses he observed in Alexandria included in his commentary to Ptolemy's *Mathematical Syntaxis (Almagest)* and elsewhere have been dated as the eclipses that occurred in AD 364, which is consistent with Suda.

Although originality in Theon's works cannot be claimed, he was certainly immensely influential in the preservation, dissemination and editing of classic texts of previous generations. Indeed, with the exception of *Vaticanus Graecus 190* all surviving Greek manuscripts of Euclid's Elements stem from Theon's edition. A comparison to *Vaticanus Graecus 190* reveals that Theon did not actually change the mathematical content of the *Elements* except in minor points, but rather re-wrote it in Koini and in a form more suitable for the students he taught (some manuscripts refer to Theon's *sinousiai*). His edition became the classic text, far overshadowing any other version.

Theon's longest and chronologically earliest work is his commentary on Ptolemy's *Almagest*, in thirteen books, written in parallel order to the great classic. The commentary survives almost intact except for Book 5, which is a fragment, and Book 11, which is lost. Before him, Pappus had also written a commentary on the *Almagest*, now mostly lost. Comparing the small common part suggests that Theon used it in his work. However, Theon is the first, as stated in its preface, to have written commentaries on Ptolemy's *Handy Tables (Canon)*. As a matter of fact, Theon wrote two commentaries

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on the *Handy Tables*, the first being the more extensive and thorough, the second being more practical and without proofs, intended for the students who were not able to understand geometry. Theon, apart from his edition of the *Elements*, also edited *Ptolemy's Handy Tables* and the Euclidean *Data* and *Optics*. The latter manuscript may in fact be notes kept by a student attending Theon's lectures on the subject, as may well be the case with a manuscript containing Euclid's *Catoptrics*. Suda mentions that Theon wrote a now lost treatise on the *Small Astrolabe* and, perhaps confusing him with the grammarian Theon, *On Risings of the Dog Star*, *On the Rising of the Nile* and one on *Omens*.

The Islamic tradition inherited and was influenced by several of Theon's works, especially the one on the astrolabe and his edition of Ptolemy's *Handy Tables*. He is included in the *Fihrist*, the famous Arabic bibliographical list.

More famous than Theon is, as he himself calls her, "*the philosopher, my daughter Hypatia*".

Among the female mathematicians of antiquity, Hypatia is certainly the most well known and, sadly, the only one about whom we have information other than a mere reference. However, through the writings of Athenaeus, Plutarch, Diogenes Laertius, Iamblichus and others we have the names and scanty pieces of information of several female mathematicians from antiquity. This information goes back as far as mythological times. For instance, in *The Banquet of the Sages (Deipnosophistai)* it is stated that Aithra, daughter of King Pittheus of Troizina and mother of Theseus, taught arithmetic. According to the same source Dafne the Athenian also taught arithmetic, in Athens. Other female mathematicians were Kalyki, Archediki, Telessina, Pythioniki, Lambito, Danae, Theokleia, Antheia and Chloe. Iamblichus and others mention that Theano, Pythagoras' wife, was versed in mathematics and so were their daughters Arignoti, Myia and Damo. The latter is said to have been the first to discover a method to inscribe a regular dodecahedron in a given sphere. From the school of Pythagoras we know of Fintys, Tymila and Melissa who, according to Vlemmidis, discovered the formula for the sum of the cubes of the first  $n$  natural numbers. Other names are Nikareti the Corinthian who, according to Argyros, discovered some of the early theorems included in Euclid's *Elements*, Aglaoniki, mentioned by Plutarch, and Leontia and Themisi of the Epicurean school. We also know of Pythais, the daughter of the mathematician Zenodorus (2<sup>nd</sup> cent. BC) and who made an important discovery on isoperimetric polygons. Finally, Proclus mentions the geometer and arithmetician Areti of Cyrene.

With such a tradition of varied degrees of reliability we come to Hypatia. She has attracted enormous attention in modern times and has been exalted to legendary proportions especially by scholars who study the gender difference in scientists. Perhaps much of our idealised image of her has been

influenced by the 1853 romantic novel *Hypatia or New Foes With An Old Face*, by the classical scholar and historian Charles Kingsley, (1819-1875). The author takes liberties in the exposition of his story which develops in the troubled times of 4th-century Alexandria. For instance Hypatia's much quoted beauty, although mentioned in some of the ancient sources, has been grossly exaggerated by Kingsley in statements like "...her features, arms and hands were of the severest and greatest type of old Greek beauty...with that firm, round ripe outline and waxy morbidezza of skin....". Such expressions abound in the novel and should not be taken literally.

In modern times interest in Hypatia commences with a biography written in 1720 by John Toland (1670-1722), a deist. The author uses Hypatia's example in an effort to defame Christianity and especially Cyril, the Archbishop of Alexandria, whom he holds responsible for Hypatia's tragic death. Already the title of Toland's 36-page pamphlet *Hypatia: or the History of a most beautiful, most virtuous, most learned, and every way accomplish'd Lady; who was torn to pieces by the clergy of Alexandria, to gratify the pride, emulation and cruelty of their archbishop, commonly but undeservedly styled St. Cyril*, prepares the reader for its point of view (Originally, the pamphlet was part of a booklet called *Tetradymus* and consisted of four essays. The 1753 edition contains a fictitious portrait of Hypatia). As expected, Toland's biography provoked a controversy, as seen for example in an anonymous publication of 1721 called *Tolando-pseudologo-mastix, an Answer to Toland's Hypatia*. The writing is attributed to John King (1652-1732) and disputes the arguments in favour of a Christian view. But the controversy does not end here. In 1776 the English historian Edward Gibbon, in Chapter 47 of his influential and widely-read *The Decline and Fall of the Roman Empire* uses eloquent and emotional language to describe both the beauty and tragic events of Hypatia's death, holding responsible the Christians and their Archbishop, Cyril.

Whatever the events in relation to Hypatia's murder in 415, about which the ancient sources are not unanimous in naming the person responsible, one thing is certain: they became a chief source of her immortality to the extent that 415 is often considered the seminal date which divides paganism from Christianity. If the closure of the School of Athens by Justinian in 527 is not a suitable conventional date for the end of paganism, then 415 certainly is a good alternative.

There are several primary sources about Hypatia's life. One is a long, but unfortunately in some respects self-contradictory article in the *Suda*. Others are John Malalas' *The Chronographia*, Socrates' *The Historia Ecclesiastica*, and the letters sent to her by her most famous student and friend

Sinesius, later bishop of Ptolemais. All these can be found in Migne's *Patrologia Graeca*. Other sources are, John of Nikiu's *The Chronicle*, *The Historia Ecclesiastica* by Philostorgius and a brief reference to her in Photius' *Bibliothiki*, in his summary of (the lost) Damascius' *Life of Isidorus*. The above-mentioned sources, all Christian and generally favourable to Hypatia, do not agree on who is to blame for her death.

There is no firm date of Hypatia's birth but it is generally given as around AD 370. This is partly because eclipses described by her father have been dated at AD 364. Hypatia was a chaste person and a respectful teacher of mathematics and neo-platonic philosophy in Alexandria. Wearing a rough cynic philosopher's cloak (trivona) she taught in public (exigeito dimosia) to an audience consisting of both pagans and Christians (Sinesius himself was a pagan who later converted to Christianity to become bishop of Ptolemais). According to *Suda*, Hypatia authored commentaries on Diophantus, on *The Astronomical Canon* and on Apollonius' Conics. (The text in *Suda* has been variously interpreted. For example, it may mean that there were just two commentaries, the one being Diophantus' *Astronomical Canon*. For various reasons, however, it seems safer to assume that it refers to a separate work of Diophantus, presumably *The Arithmetica*, and then to Ptolemy's *Almagest* or the *Handy Tables*.) Hypatia also collaborated with her father on a commentary of the third book of Ptolemy's *Almagest* since the text includes the phrase "this book was revised/edited (*paranagnostheisa*) by the philosopher, my daughter Hypatia". A quotation in one of Sinesius' letters stating that Hypatia helped him design an astrolabe shows the breadth of her knowledge. In yet another letter Sinesius requested her to construct a hydrometer (hydroscopeion) according to his detailed instructions.

There is no doubt that Hypatia was the leading mathematician of her time. However, it seems that no specific original contributions to mathematics or astronomy can be attributed indisputably to her. Whatever her contributions, if any, they are either lost or perhaps diffused in her commentaries. Like her father, she is mostly remembered for her teaching.

The most detailed and reliable account of Hypatia's death is narrated by the historian Socrates some twenty-five years later. At the time described, there was considerable tension and rivalry especially between the Jews and the Christians of Alexandria. In those difficult times the prefect of Alexandria, Orestes, and the Archbishop Cyril, known for his harsh way of dealing with the heretic Nestorius, opposed each other. Some five hundred monks from the monasteries in Nitria, referred to as savages, (*thirioeis*) by *Suda*, came into town to support Cyril. They accused Orestes (who had been baptised a Christian) for being a pagan and sacrificing to the Greek gods in spite of emperor Theodosius' ban of all pagan cults. When a monk named Ammonius met his death by torture for hurling a stone at the prefect, Cyril

and many moderate Christians found this action intolerable. The pro-Cyril mob turned against Hypatia, Orestes' close associate. Although the prevailing opinion is that Cyril was directly to blame, there is no evidence that he actually gave orders to or knew of the mob's intention. Indeed, John of Nikiu is even favourable to Cyril calling Hypatia a pagan magician, and Philostorgius put the blame on a pro-Arian mob. Be it as it may, Hypatia was stripped and violently dragged to the Cathedral where she was killed and subsequently cut to pieces with sharp oyster shells. Her dismembered body was then taken to a location called Dog's Place (Kynarion) and finally burnt.

Such is the story of the most famous ancient female mathematician.

*Further reading.* Except for the sources mentioned in the text, it is recommended to read the following and the references given there.

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