

Hundreds of years after the first try, we can finally read a Ptolemy text

Enlarge / An artist's conception of Ptolemy using an instrument to observe the night sky.

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It was only natural for Alexander Jones to feel thrilled when he saw a sixth century palimpsest at the Ambrosiana library in Milan for the first time. It happened in 1984 when Jones was working on his dissertation using manuscripts in Italy. With the tools at his disposal, including a portable ultraviolet lamp and microfilm, he could only read a few lines. But Jones' interest was piqued because there were pages of the text that *no one* had succeeded in reading.

Those pages remained unread until this year when a large part of the text was deciphered by Jones, a professor of History of the Exact Sciences in Antiquity at New York University, who worked with Victor Gysembergh and Emanuel Zingg of the Paris-based Léon Robin Centre. The material they discovered appears to be a copy of Claudius Ptolemy's treatise on a scientific instrument called the meteoroscope.

Finding Ptolemy

Ptolemy, who was born in 100 CE, was a renowned astronomer and mathematician who authored several important works, including *Almagest* and *Geography*. The treatise on the meteoroscope is a description of how to use the instrument for observations, as well as for doing astronomy calculations.

“The Meteoroscope (copy) was written in Greek on parchment sheets. Two centuries later, it was erased to write a manuscript in Latin called *Etymologiae* by Isidore of Seville. This kind of recycling was a pretty common practice in the Middle Ages as parchment was very expensive,” Jones said.

According to Gysembergh, the eighth century *Etymologiae* manuscript runs into several hundred pages. “Thirty of these are recycled, the majority of which contain text from Ptolemy’s works. Of the 30 pages, 12 are dedicated to the Meteoroscope.” The other pages of the manuscript contain text of another work of Ptolemy’s called *On the Analemma*, which was read in 1895 by the Danish scholar J.L. Heiberg.

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The reuse of the parchment for the Latin manuscript meant there were faint remains of the previous text. Attempts to reveal the original text were made for the first time in the early 19th century. “Cardinal Angelo Mai, who discovered that the manuscript contained scientific text, applied chemicals hoping they would bring out the faint traces of ink. Now, those pages are big brown rectangles where you can hardly see anything. The new technology has done wonders to bring out the traces through the chemicals,” Jones said.

New tech meets old parchment

The technology that revealed the text consists of a multispectral camera and image processing software. Gysembergh

remembered being struck by its potential when the Archimedes palimpsest was decoded. "As a student back then, I was fascinated that cameras could be used to discover new texts," he said.

It was during a chance meeting between Gysembergh and Jones in 2019 that the seed of their research project was sown. Gysembergh was looking for interesting ideas for research when Jones pointed out the palimpsest at the Ambrosiana library. The project was set in motion after receiving funding from Sorbonne University.

The multispectral imaging of the palimpsest was carried out in January 2020. This was done using a 240 million-pixel camera and processing software called Layer Amplification Method, both of which were developed by Pascal Cotte of Lumiere Technology.

The camera is equipped with 13 wavelength filters that allow the imaging of an object in ultraviolet, visible, and infrared wavelengths ranging from 380 to 1,050 nanometers. The camera has a high dynamic range and can focus separately for each wavelength.

"We illuminated the palimpsest pages with ultraviolet and pure white light. Using the filters, we measured the interaction of the light at different depths inside the parchment. For each wavelength, this interaction was different. We took 1,650 images and processed them using LAM software to reveal the Greek text," Cotte said.

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Gysembergh said the images were additionally processed by a team from the Early Manuscripts Electronic Library.

After deciphering the text, the researchers could associate it with Ptolemy. "Being an expert on Ptolemy's works, I was aware of his distinctive verbal mannerisms which were present in this text. While there are other items of evidence, the

strongest was on a page where the writer mentions new names to angles in astronomy and describes what the old names were. This exactly matches a passage in another book of Ptolemy's where the same terminology is used," Jones said.

"Also, it was known that Ptolemy had invented and written on such a scientific instrument because he mentioned it in his book on map making," he added.

Jones said the text describes how the instrument could be used to measure angular coordinates, determining the location of a planet in the night sky. This was done by turning the instrument's movable rings so that the planet could be sighted along the faces of certain rings. "Thereafter, the angles can be read on degree scales inscribed on the rings," Jones said

"As a calculator, one could arrange rings according to known data such as the latitudes and longitudes of two cities and read an angle representing the length of the shortest possible path from one city to the other," he added.

According to Jones, the aspect that makes this text stand out is the detailed explanation of how each instrument component is made. "It's a kind of technical writing. It's the first book of its kind on scientific instruments from ancient times with that level of detail," he said.

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