

The virtual unwrapping of Herculaneum papyri scrolls

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The virtual unfurling of a Herculaneum carbonised scroll and the posting of the full text of a carbonised scroll along with the partial reading of two other scrolls represents a major advancement for science and the study of ancient Greek and Roman thought. The virtual reading of the scrolls using AI algorithms demonstrates the fundamentally progressive nature of what the Marxist movement has called augmented intelligence.

On June 25 the Vesuvius Challenge held a press conference at the Vittorio Emanuele III National Library in Naples, titled “*Reading the Unreadable: Recovering Lost Ancient Texts from Herculaneum*,” announcing the complete virtual unwrapping and first end-to-end reading of a carbonized Herculaneum scroll designated PHerc. 1667. The text spans about 1.4 metres of papyrus across 22 columns of ancient Greek. Even though there are many gaps in the text due to the poor condition of the scrolls, researchers obtained full sections of text. Previous attempts to unravel the scroll had caused severe damage reducing it by half with a portion only 8 centimeters tall by 2 centimeters wide remaining.

The scrolls were originally excavated from a villa located in Herculaneum on the bay of Naples in southern Italy between 1750 and 1752 by the Swiss engineer Karl Weber. The villa was thought to have belonged to the father-in-law of Julius Caesar, Lucius Calpurnius Piso Caesonius, and is now known as the Villa of the Papyri. The collection of over 1,800 scrolls was completely carbonised and buried under 18 to 28 meters of volcanic ash in the famous eruption of Mount Vesuvius in 79 CE, which also wiped out the neighbouring town of Pompei.

The Herculaneum scrolls represent one of the most monumental discoveries in classical archaeology and constitute the only library from antiquity to survive in its entirety. The vast majority of the scrolls are stored in Naples, while six are held at the Institut de France in Paris and four at the Bodleian Library in Oxford.

The final column of the scroll designated PHerc. 1667 mentions Aristocreon, who was the nephew and disciple of the major Stoic philosopher Chrysippus. Due to this reference, scholars think the text may have been authored by Chrysippus. The scroll is a Stoic philosophical treatise on ethics and human behaviour from the 2nd-century BC. There are no known works by Chrysippus in existence, with his work only known through fragments quoted in other sources.

The text comments on human nature: “we will inquire into something, but we will not grasp it, if in some way we depart from ourselves and from our own nature...”; on reason and wisdom: “Having... strained ourselves to the utmost through research and learning... possessing the same practical wisdom...”, and on Stoic Ethics: “such being the goods for us, even from the opposite evils there will be neither anything good—let alone beautiful—nor anything bad—let alone ugly—nor happiness...” It is an extraordinary feat of science that these texts can now be read and studied after almost 2,000 years.

A papyrologist at the University of Naples Federico II, Federica Nicolardi, told the *Guardian*: “We don’t have the full scroll, but the

surviving object was unwrapped and that’s a very important result because it shows that we are able to unwrap these objects completely.”

Nicolardi continued: “At first, we were saying this could be an Epicurean talking about Stoic doctrine. But then I stopped and said, you know, if this was found outside of Herculaneum, we would categorise it as a Stoic work.” Epicureanism was an ancient materialist philosophical school and was thought to be the central focus of the Herculaneum library.

Researchers conducted ultra-high-resolution 3D X-ray scans of a second scroll designated PHerc. Paris 4 making the ink directly visible inside the 3D tomographic volume for the first time. This physical evidence perfectly matched the initial AI-assisted readings. An earlier AI reading of the scroll found approximately 15 columns of text containing over 2,000 Greek characters, representing about 5 percent of the total scroll. The already revealed text indicates an Epicurean treatise on pleasure, discusses music, food and how to enjoy life’s goods without allowing scarcity to diminish that pleasure.

In their analysis of PHerc. 139 researchers were able to determine the author and the title of the work, “Philodemus, On Gods, Book 8”. Philodemus was an Epicurean poet and philosopher who was thought to be the librarian of the papyri scrolls. Previously only his poetic works had survived, but philosophical texts are being uncovered in the Herculaneum collection.

The presence of works and commentaries of rival philosophical tendencies attests to the dynamism of ancient Greek and Roman society. “Stoics and Epicureans were rival schools [but] debates and polemics between them were common,” Nicolardi explained to the *National Geographic*.

The team published their findings in a preprint paper by an international team including Vesuvius Challenge Project Lead theoretical physicist and AI researcher Giorgio Angelotti and professor of computer science at the University of Kentucky W. Brent Seales, titled “Complete virtual unwrapping and reading of a rolled Herculaneum papyrus.” They scanned the scrolls using X-ray micro-computed tomography used to create a virtual model that is combined with the virtual unwrapping of the scrolls.

Distinguishing the ink from the carbonised papyrus was extremely difficult, as both were mostly composed of carbon. The researchers relied on detecting metallic contaminants in the ink and miniscule surface features. They stated, “Subsequent work showed that useful signals may arise from metallic components in some inks, from hyperspectral contrast in opened material, or from fine surface deformations associated with ink on fragments.”

The importance and difficulty of the work was highlighted by the fact that all previous attempts to mechanically unwrap the scrolls since their discovery has led to their destruction. PHerc. 1667 had been reduced by half by earlier attempts to physically unroll it. In the 1980s, scholars used a mixture of gelatine and acetic acid in an attempt to soften the scroll only to see it crumble into an unreadable mass except for a few fragments.

The three scrolls the researchers analysed were scanned at the European

Synchrotron Radiation Facility in Grenoble in France and the Diamond Light Source in Harwell Science and Innovation Campus in Oxfordshire in the UK. This enabled the researchers to obtain three-dimensional representations of the scrolls without harming the carbonised papyrus.

The researchers make the important point that the success of their current work doesn't mean other scrolls will be as readable, due to the damaged nature of the papyri.

"This workflow does not imply that all sealed Herculaneum rolls are automatically readable. Performance depends on scroll general preservation state, scan quality, layer separation, deformation, local ink contrast and surface preservation," their paper states.

Seales' role was central to the development of the possibility of virtually reading the scrolls. He was told about the scrolls in 2004 by the classicist Richard Janko at the University of Michigan.

"I knew instantly, instantly, that if it could be solved, it would be amazing, and the world would think it was amazing," Seales told *On Wisconsin*.

In 2009 Seales conducted a micro-CT scan of PHerc Paris 4 from the Institut de France that provided the first volumetric image showing the internal structure of the scroll, laying the groundwork for the virtual unwrapping.

The next breakthrough was unwrapping in 2015 of the carbonised En-Gedi scroll that had been discovered in the ruins of an ancient synagogue at Ein Gedi, Israel in 1970. The scroll contained the opening verses of the Book of Leviticus written in Hebrew. Unlike the Herculaneum scrolls, the writing was detectable as a metallic based ink was used to write the En-Gedi scroll.

Seales' work up to 2022 received traditional academic funding, including grants from the National Science Foundation, the National Endowment for the Humanities and the Mellon Foundation, but he had reached a bottleneck as these sources weren't able to supply the necessary funds needed for the complex work. In 2022 Seales met American technology executive and investor Nat Friedman and Israeli-American businessman Daniel Gross who suggested that the research could be funded through turning to tech entrepreneurs. The funds would be used for a series of competitions open to the public to solve various aspects of the research. In total \$6,559,000 was raised, with Friedman contributing \$2,250,000 while Elon Musk's Foundation contributed \$2,084,000. To the scientists' credit all their findings were completely open and accessible on the internet to interested scholars who could contribute to the project.

Musk's involvement is particularly revolting. While his contribution would be small change from his fortune, his basic orientation is the antithesis of science. He has promoted and funded the fascist right globally and regularly promotes bigoted and racist tropes such as the antisemitic Great Replacement Theory. The concept of race is a political construct that has been shown repeatedly as having no basis in science and is used to scapegoat and divide the working class. Musk's contribution of a derisory amount to the Vesuvius Challenge doesn't offset his overall anti-science focus.

Nor does Musk's involvement detract from the cultural and scientific value of the researchers' achievement. On October 12, 2023 the Vesuvius challenge announced that a 21-year-old computer science student from the University of Nebraska-Lincoln, Luke Farritor, had developed an AI model designed to detect subtle, microscopic variations in surface texture, known as "crackle," left behind by the ancient ink. This enabled him to read the word "purple" written in ancient Greek. A few days later a student from Berlin Youssef Nader identified the same word using a different AI model he had devised. In February 2024 Farritor and Nader along with another student Julian Schilliger identified more than 2,000 characters making up 15 columns of text scroll PHerc. Paris. 4.

"Sometimes we take breakthroughs such as this for granted, but we should not. It took the combined efforts of many people over several centuries to discover, preserve, scan and now, finally, read and translate these scrolls. It is the privilege of a lifetime to be a small part of this," Farritor told the University of Nebraska Lincoln online journal.

An Epicurean library

It was known soon after the discovery of the scrolls in the 18th century that the Herculaneum library was devoted to Epicureanism, that is materialism.

Epicurus was a materialist philosopher who lived in Athens around 307 BCE. He considered that the universe consists entirely of indivisible material atoms moving through infinite empty space. He saw the soul as physical and made of atoms, it dissolves completely upon death; therefore, there is no soul surviving in an afterlife or divine punishment to fear. He thought that gods existed but that they were made of atoms and that they were detached from human society.

The researchers' project of transforming the carbonised scrolls into a readable form is of decisive importance to Marxists. Marx wrote his doctoral dissertation of 1841 on "*The Difference Between the Democritean and Epicurean Philosophy of Nature*." Democritus was a pre-Socratic philosopher who advanced an atomic theory of the universe.

Four years later in his *Holy Family* Marx recognised the seminal importance of Epicurus on the future development of materialism: "The metaphysics of the seventeenth century, represented in France by Descartes, had materialism as its antagonist from its very birth. The latter's opposition to Descartes was personified by Gassendi, the restorer of Epicurean materialism. French and English materialism was always closely related to Democritus and Epicurus."

René Descartes was a 17th century French metaphysical dualist philosopher and mathematician. Pierre Gassendi was a 17th century French mechanical materialist philosopher and scientist who is considered to be pivotal to the development of the modern scientific outlook.

Epicureanism was an important philosophy that influenced the development of the Renaissance and subsequently the Enlightenment. American founding father Thomas Jefferson considered himself an Epicurean.

Commentary on the virtual unwrapping of the ancient papyri fails to explain why the Villa of Papyri scrolls are the only extant ancient library.

The only Epicurean text still in existence is by Roman poet and philosopher Titus Lucretius Carus *De rerum natura* (*On the Nature of Things*). Lucretius was a contemporary of Philodemus. Stephen Greenblatt in his book *The Swerve: How the Renaissance Began* on the rediscovery of Lucretius's work by the Italian humanist Poggio Bracciolini in 1417 at a German monastery explains the fate of ancient learning.

With the rise of Christianity in the Roman empire the relative tolerance of different philosophical and religious tendencies came to an end. Under this new regime Epicureanism became a proscribed tendency.

Christians undertook a slander campaign against figures such as Lucretius. Greenblatt cites the slanders spread by St Jerome who lived in the fourth century BCE. In his *Chronicon* (*Chronical*) written in 380 CE he stated "Titus Lucretius, poet, is born. After a love-philtre had turned him mad, and he had written in the intervals of his insanity, several books which Cicero revised, he killed himself by his own hand in the forty fourth year of his age." Subsequent writers repeated and amplified the slanders aimed at discrediting Epicurean thought as promoting a libidinous lifestyle.

The Romans were known at the period of the Villa of the Papyri as lovers of books. Many wealthy Romans had extensive libraries and numerous public libraries existed in Rome and throughout the empire. Greenblatt describes the fate of the largest and most consequential library in ancient times in Egypt in Alexandria.

The library started in early 300 BCE under the Ptolemaic kings. It was a major repository of ancient culture. Figures such as the renown mathematicians Euclid, Archimedes and Eratosthenes were known to have worked at the library. At its height the library held half a million works.

Greenblatt explains the importance of the library: "It represented a global cosmopolitanism, a determination to assemble the accumulated knowledge of the whole world and to perfect and add to this knowledge."

In the fourth century Christianity became the official religion of Rome. The Roman Emperor Theodosius the Great issued the Edict of Thessalonica in 380 CE, making Christianity the mandatory state religion and banning what he defined as pagan practices.

This sealed the fate of the Alexandria library as Christian mobs were given licence to hunt down and destroy paganism. In about 415 CE the Christian Patriarch Saint Cyril of Alexandria ordered the expulsion of the Jews and the seizing of their synagogues.

The great mathematician and scholar Hypatia, who worked at the library, was murdered in 415 CE for opposing the expulsion of the Jews. Her skin was flayed off, and her body was dragged through the streets to the outside of the city and burned.

The great Library of Alexandria had been largely destroyed by civil wars and fires centuries before Christian dominance, but subsequent religious friction targeted pagan intellectual hubs. In 391 CE, the Serapeum of Alexandria, which housed a daughter library, was destroyed by order of the Christian bishop Theophilus. In 529 CE, the Christian Emperor Justinian effectively closed the Neoplatonic Academy of Athens by banning non-Christians from teaching, forcing them to flee to Persia.

Greenblatt concluded, "Compared to the unleashed forces of warfare and of faith, Mount Vesuvius was kinder to the legacy of antiquity."

The reading of the Herculaneum papyri and the revelation of the Epicurean and materialist core of the library is a massive blow to religious obscurantism. It has provided a tantalising glimpse of its contents that will be followed eagerly.



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