

Tenth Century manuscript provides insights into the works of Archimedes

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The announcement on July 11 of the availability of a tenth century manuscript of texts by the Greek scientist and mathematician Archimedes offers an important opportunity to probe the works of one of the greatest thinkers of the ancient world. The document provides the oldest known source of Archimedes' writings. Scientists at Rochester Institute of Technology (RIT) and Johns Hopkins University in Baltimore have been given access to portions of the Archimedes Palimpsest by the Walters Arts Gallery in Baltimore as part of a competition to determine which team will decipher Archimedes' entire text. The original work lies hidden beneath an overlay of Greek prayers. A palimpsest is a document where the original script has been scraped or washed away and another text written over the top.

Scientists will be using the latest technology such as digital enhancement and ultra-violet and infra-red filters to discern the original text. Some of the inks used contain particles of iron and will be analyzed using delicate magnetic equipment. An RIT archaeologist, Robert Johnston said that "there is always a residual, traces of what was there. It's amazing what can come out. Soon, nothing will be secret or hidden." Curator of the Walters Arts Gallery, William Noel noted the significance of the work as "Archimedes' brain in a book. What we need to do is X-ray that brain."

The Palimpsest is the only copy of Archimedes' important *On the Method of Mechanical Theorems* and the original Greek version of *On Floating Bodies*. It also contains copies of Archimedes' *On the Measurement of the Circle*, *On the Sphere and the Cylinder*, *On Spiral Lines* and *On the Equilibrium of Planes*, which had previously been known from much later sources.

The manuscript was written in the tenth century from a copy of Archimedes' work in the city of

Constantinople, present day Istanbul. In that period books were made from leaves of parchment bound between wooden boards. Constantinople was the intellectual center of the world and the works of ancient Greek philosophers and scientists were copied by scribes and made available to scholars. Two hundred years later the original text was scraped off and rewritten as a prayer book.

In 1204 crusaders sacked Constantinople and burnt many of the books and historic monuments. Fortunately the Archimedes Palimpsest survived. The document is recorded in various periods, including in the sixteenth century at the Monastery of St. Saba in what is now Israel and in 1846 at The Church of the Holy Sepulchre in Constantinople. It was in this period that the prayer book was first identified as a palimpsest. In 1906 the Danish philologist Johan Ludvig Heiberg transcribed the faint mathematical text using a magnifying glass and identified the work as that of Archimedes. The Palimpsest ended up in Paris in 1930 and remained there until 1998, when it was brought to the United States.

Archimedes lived on the island of Sicily in the third century BC and was one of the ancient world's greatest engineers, physicists and mathematicians. He developed the science of hydrostatics and invented the Archimedes screw, a device used to lift water. Archimedes is best known for his solution for determining if a crown had been made from pure gold or adulterated with silver without damaging the crown. Legend has it that when he was taking a bath he noted he was displacing a certain amount of water as he lowered himself into the water. Thus he determined that the crown would also displace a set amount of water depending on its composition. He was so excited by the solution that he ran out of his house naked shouting

“Eureka!” the Greek word for “I’ve found it!” The fact that such stories have endured in the popular imagination testifies to the impact of Archimedes’ work.

Archimedes was a noted engineer and used his skills in the defense of Syracuse against invasion from the Romans. He was set to work strengthening the walls of the city and building war machines. The city withstood the siege for two years but unfortunately he was killed at the end of the siege. The Romans erected a tomb in his honor inscribed with the image of a sphere within a cylinder in tribute to his great mathematical discoveries.

In *On the Sphere and the Cylinder* he developed the formulae for the surface area and volume of a sphere. This used the concept of infinitesimals, a quantity less than any finite quantity but not zero, which anticipated the discovery of calculus almost two thousand years later. In *On the Measurement of the Circle* he provides an approximation for pi, the ratio between the circumference and diameter of a circle. *On Floating Bodies* determines the positions objects will float in a liquid depending on their form and specific gravity. The second part of this document is regarded as the greatest achievement of ancient Greek mathematics.

The most significant work contained in the Archimedes Palimpsest is *On the Method of Mechanical Theorems*, which describes his method for mathematical discovery. Archimedes developed mathematical physics, that is the use of rigorous mathematical proofs to elucidate physical principles. This method became central in the work of later mathematicians and physicists such as Johannes Kepler, who discovered the laws of planetary motion, and Isaac Newton, who elaborated the general laws of motion.

The scientific teams working on the Archimedes Palimpsest anticipate they will be able to decipher the whole document but, whatever the result, one hopes that the material produced will spark a renewal of interest in this great scientist and mathematician.



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