

Euclid and His Heritage Meeting

Speakers' Talks

From Euclid to Arethas

Alexander Jones (University of Toronto)

Rethinking the *Elements* – two thousand years of reflections on the foundations of geometry

Jeremy Gray (Open University)

The *Elements*: The transmission of the Greek text

Nigel Wilson (University of Oxford)

New technologies for the study of Euclid's *Elements*

Mark Schiefsky (Harvard University)

The mathematical legacy of Euclid's *Elements*

Robin Hartshorne (UC Berkeley)

Euclid's *Elements* in Hebrew

Tony Lévy (CNRS, Paris)

Interpreting Euclid – early and late

Bill Casselman (University of British Columbia)

Who started the Euclid myth?

Ian Mueller (University of Chicago)

Euclid's *Elements* in the Islamic world

Sonja Brentjes (Aga Khan University)

Clay mathematics: Euclid's Babylonian counterparts

Eleanor Robson (Cambridge University)

The Heiberg Edition of Euclid's *Elements*: an incorrect text or a false history of the text?

Bernard Vitrac (CNRS, Paris)

Euclid in Chinese... and in Manchu

Catherine Jami (CNRS, Paris)

The achievements and limitations of the theory of proportion in Euclid's *Elements* Book V

Christopher Zeeman (Warwick Mathematics Institute)



Speaker Christopher Zeeman

On October 7 and 8, 2005, the Clay Mathematics Institute held a conference, "Euclid and His Heritage," which brought classicists, historians, mathematicians and philosophers together to examine the transmission and influence of the founding document of mathematics. The occasion of the conference was the publication, for the first time, of a complete digital image of the oldest surviving manuscript of the *Elements* – a copy made by Stephen the Clerk for Arethas of Patrae, deacon and later bishop of Caesarea in Capadocia, in Constantinople in the year 888 AD. The digital copy of the manuscript, which resides at the Bodleian Library, Oxford University, was produced by Octavo.com with support from the Clay Mathematics Institute.



The panel discussion at the conclusion of the conference

Speakers' Abstracts

Sonya Brentjes outlined current research on the transmission of the Arabic text of Euclid's *Elements*, including the remarkable variability of the text, differences with the Persian texts, and the scholarly as well as broader cultural relevance of the text and its transmitters.

Bill Casselman discussed the role of figures in geometry, beginning with one of the earliest extant, from Elephantine Island, dating from the 2nd century BC, ending with modern computer graphics, and discussing along the way the most complicated figure from ancient mathematics, the construction of the Icosahedron in Euclid's book XIII.

Jeremy Gray discussed the conceptual basis for Euclid's *Elements*: is the work about triangles, circles, etc., or is it about the notion of length and angle? Debates on the conceptual basis bear on fundamental problems such as that of the parallel postulate.

Robin Hartshorne spoke about the mathematical content of the *Elements* and of developments arising from this work: axiomatic foundations of geometry, the discovery of non-Euclidean geometries, the development of the real number system, and connections between geometry and modern algebra and analysis.

Catherine Jami discussed the long geometric tradition in China, the introduction of Euclid's work by the Jesuits in the late 16th century, and the appropriation of mathematics by Kangxi (1662–1722), second emperor of the Qing dynasty (1644–1911), for whom the *Elements* were rewritten, first in Manchu, then in Chinese.

Alexander Jones surveyed what we currently believe is the history of Euclid's *Elements* and its use in the Greek-speaking world during its first twelve centuries, starting with the elusive Euclid himself.

Tony Lévy discussed the Hebrew transmission of the Euclidean text: four different versions translated from Arabic sources, including that of Moses in Tibbon, completed in Provence in 1270, as well as Avicenna's (Ibn Sina) *Foundations of Geometry*, a shortened Arabic version of Euclid's *Elements*.

Ian Mueller spoke about the claims of indubitability (or certainty) in sixteenth-century discussions of mathematics and the role of the work of Proclus and Averroes in these discussions. An important historical factor was a misunderstanding of the Greek word for exactness or precision, *akribeia*.

Eleanor Robson reminded us that Euclid's contemporaries in Hellenistic Babylon were heirs to a mathematical tradition at least as ancient as Euclid's is for us today. Robson explored the lives, works, and motives of the Babylonian mathematicians to better understand the extraordinary nature of Euclid's achievement in the context of his time.

Mark Schiefsky explored contributions of information technology to the study of Euclid's *Elements*, e.g., linking of electronic versions of the text to online manuscript images; linguistic technology for the analysis of parallel versions in different languages; mapping of deductive structures and their visual representation.

Bernard Vitrac recalled that since the 1990s, the adequacy of Heiberg's work establishing what is still the latest critical edition of the Greek text of the *Elements* has been questioned. In light of this, Vitrac discussed the contributions of Arabic and Arabo-Latin texts to the debate.

Nigel Wilson spoke on how Euclid's *Elements* was transmitted through the long period in which handwritten copies were the only means of preserving a text. Wilson illustrated his remarks with examples taken from the Bodleian Library Manuscript (888 AD) and some of the marginal notes therein written by medieval scribes.

Christopher Zeeman discussed the mathematics of Book V of the *Elements*, which is an exposition of the work of Eudoxus. Zeeman noted that in Euclid's framework one could not define the ratio of two ratios. However, the introduction of a new axiom for magnitudes, related to the Archimedean axiom but excluding infinitesimals, resolves the problem.