Leonhard Euler: 300 years old

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Purdue University

March 22, 2007
The three stations of Euler’s life
Basel 1707–1727
St. Petersburg 1727–1741
Berlin 1741–1766
St. Petersburg 1766–1783
The Man
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Auspicious beginnings
Chronology

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- left Basel (for good) in April of 1727 to assume a junior appointment at the Academy of St. Petersburg
St. Petersburg 1727–1741

Meteoric rise to world fame and academic advancement
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• groundwork for Euler’s appointment at the Academy had been laid by Johann Bernoulli and his sons Niklaus II and Daniel I, both already active at the Academy

1731: professor of physics; ordinary member of the Academy
1733: succeeds Daniel Bernoulli (who returns to Basel) as professor of mathematics
1734: marriage to Katharina Gsell, which brought forth 13 children of whom only 5 reached the age of adulthood
1735: first setback in health
1738: second setback in health; loss of the right eye
1741: departure from St. Petersburg following political unrest after the death (1740) of the Empress Anna Ivanovna (a niece of Peter I); accepted an invitation of Frederick II to help set up an Academy in Berlin.
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Mechanics: Analytic theory of motion (1736)
- kinematics and dynamics of a mass point
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Naval science (1749, written 1740–41)
- principles of hydrostatics
- stability theory
- naval engineering and navigation (vol. II)
Selecta Euleriana

Selectio 1 The Basel problem (1740)
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\[ 1 + \frac{1}{2^2} + \frac{1}{3^2} + \frac{1}{4^2} + \cdots = \]

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zeta function

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Euler determines \(\zeta(4), \zeta(6), \zeta(8), \ldots, \zeta(12)\)
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Later in 1750, he was able to prove (rigorously)

$$\zeta(2n) = \frac{2^{2n-1}}{(2n)!} |B_{2n}| \pi^{2n}$$
Selectio 2 Prime numbers and the zeta function
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Euler’s derivation

from \( \zeta(s) \) “peel away” all terms divisible by 2

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from this do the same with the prime 3, then with 5, etc.
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\[
\left( \prod_{p \in \mathcal{P}} \frac{p^s - 1}{p^s} \right) \zeta(s) = 1 \quad \square
\]
Berlin 1741–1766

The emergence of epochal treatises
Chronology

- 1746: Berlin Academy opens its doors, with Maupertuis its president and Euler the director of the Mathematics Class;
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Major treatises

Methodus inveniendi lineas curvas (1744)

- one of Euler’s masterpieces: the first exposition ever of the calculus of variations
- Euler’s differential equation
- numerous examples from mathematics and the natural sciences
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Artillery (1745)
- vastly expanded and annotated German translation of Robins’s New principles of gunnery (1742)
Introduction to the analysis of the infinite (1748)
Differential calculus (1755)
Integral calculus (1763, 1773)
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Letters to a German princess (written 1760–1762)
  • Euler’s philosophical views on science, religion, and ethics
Selecta Euleriana

Selectio 3 The Königsberg bridge problem (1741)
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connected graph

• path    • circuit    • Eulerian path or circuit
Selecta Euleriana

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Theorem (Euler) Let $n$ be the number of vertices of odd degree.
(a) If $n = 0$, the graph has at least one Eulerian circuit;
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Königsberg bridge graph:  $n = 4$
Selectio 4 Euler flow (1757)
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Transonic Euler flow at Mach .85 about a cylinder
Selectio 5 Euler’s polyhedral formula (1753)
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In a three-dimensional convex polyhedron let

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\[ V = \text{number of vertices} \]
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Theorem (Euler)

\[ V - E + F = 2 \]
St. Petersburg 1766–1783

The glorious final stretch
Chronology

• 1771: Euler loses his (good) left eye following a cataract operation and becomes virtually blind;
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• 1773: Euler’s wife Katharina dies

• 1776: Euler remarries

• 1783: On September 18, Euler dies of a stroke
Major treatises

Algebra (1770)

- a work written for the absolute beginner; a prime example of Euler’s extraordinary didactic skill; it becomes another “bestseller”, translated into all major languages
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Second theory of ships (1773)
- construction and maneuvering of ships
- written for people (e.g., sailors) with no, or little, mathematical knowledge
Selecta Euleriana

Selectio 6 Euler’s disk
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Selection 7  Gear transmission; Euler’s tooth profile
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Personality

• modest, inconspicuous, uncomplicated, yet cheerful and sociable
• “honesty, uncompromising rectitude—the acknowledged national virtues of Swiss people—he possessed to a superior degree” (Fuchs)
• free of priority concerns
• generous in acknowledging and furthering other people’s work
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Craftsmanship
• superb expositor
• his goal: ultimate clarity and simplicity
• yet fearless and aggressive in his quest for discovery
Epilogue

LEONHARD EULER
1707–1783
mathematician, physicist, engineer, astronomer and philosopher, spent his youth in Riehen. He was a great scholar and a kind man.