2020-11-27

Carl Friedrich Gauss (1777-1855)

- child prodigy: supposedly corrected his father's arithmetic at age 3
- supported by the Duke of Braunschweig ("Brunswick") in university
  (1792-1795 Collegium Carolinum, 1795-1798 Univ. of Göttingen)
  (stayed on as a professor)

- he was married twice (his first wife died) and had six children.
  - didn't get along with his older sons, the two oldest emigrated to the United States
  - his environment was disrupted several times by the Napoleonic Wars in his youth, after which he had a life-long distrust of revolutions
  - in middle age he decided to become financially independent and accumulated a small fortune by speculating in railroad stocks.

He worked in a number of areas of mathematics and physics, including geometry, number theory, algebra, analysis, statistics, astronomy, electromagnetism, optics, geodesy, etc

Published little in comparison to his actual work: he was a perfectionist with the motto "Pauca sed matura." ("Few but ripe.")
Even so, his collected published works fill 10 volumes.

Geometry: • in his teens found a ruler-and-compass construction of a regular 17-gon [open for nearly 2000 years], and this decided him to do mathematics rather than philology [study of ancient texts].

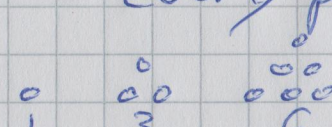
- invented but didn't publish hyperbolic geometry
- did seminal work in differential geometry (the study of "smooth" curves and surfaces) - proved that the curvature of a surface can be determined by measuring angles and distances within the surface [this crossed over with his work on geodesy].

Number theory: - (re) invented modular arithmetic and also (re) conjectured the Prime Number Theorem

- proved the Law of Quadratic Reciprocity
- proved that every prime p has a primitive root

  i.e. there is a $g \in \{0, \ldots, p-1\}$ such that $1, g, g^2, \ldots, g^{p-2}$ are all distinct $(\text{mod } p)$

- every positive integer is the sum of at most three triangular numbers



$\frac{n(n+1)}{2}$

Statistics: • discovered the (standard) normal (or Gaussian) distribution

$$\left(f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/2\sigma^2} \right)$$

mean μ & stand. dev. σ

by analyzing errors in tables of astronomical observations

• also (rr) discovered the method of least squares

Analysis: • Gauss' Theorem, usually the Divergence Theorem, in multivariate calculus

• worked on series, and devised Gauss' Test, one of the most sophisticated tests available when the Ratio Test fails.

On the physics side: (applied math)

Astronomy: - improved methods for calculating orbits as precisely as possible from limited observations
- predicted where to find the asteroid Ceres after it passed behind the sun shortly after being discovered

Electromagnetics: - much was in collaboration with the physicist William Weber

- worked out how to measure magnetism in units related to mass, length, and time
  [fundamental unit of magnetism is the "gauss"]
- discovered Kirchhoff's Laws for circuits before Kirchhoff...
- discovered Gauss' Law for relating the distribution of electric charge to the resulting electric field.
  [Nowadays enshrined as one of Maxwell's Laws for electromagnetism.]
- helped build (possibly) the first electromagnetic telegraph in 1833