A Brief History of Orbital Mechanics

Aristotle  (384-322 BC)
Ptolemy  (87-150 AD)
Nicolaus Copernicus (1473-1543)
Tycho Brahe  (1546-1601)
Johannes Kepler  (1571-1630)
Galileo Galilei  (1564-1642)
Sir Isaac Newton  (1643-1727)
Aristotle and Ptolemy

~300 BC → ~100 AD

- Earth at center of universe
- Observations don’t agree, hence Ptolemaic view
Aristotelian to Copernican
Geocentric to Heliocentric
300 BC to 1500 AD
Tycho Brahe’s Island
Hven in the Sont near Copenhagen
(1546-1601)
Kepler (1571-1630)

- Worked as assistant to Brahe in Prague
- “Inherited” Brahe’s observations
- Used curve fits to establish three laws of orbital motion

I. The orbit of each planet is an ellipse with the Sun at one focus.
II. The line joining the planet to the Sun sweeps out equal areas in equal times.
III. The square of the period of a planet’s orbit is proportional to the cube of its mean distance to the sun.
Galileo (1564-1642)

• Perhaps the first experimental physicist
• First telescope: Galilean moons
• Mathematics professor at University of Pisa
• Determined the “pendulum” principle while observing chandelier motion in church
• Sentenced to house arrest for advocating the Copernican view of the universe
Newton (1643-1727)

- **Kepler’s Laws** were based on observation data: “curve fits”
- **Newton established the theory**
  - Universal Gravitational Law
    \[ F_g = -\frac{GMm}{r^2} \]
  - Second Law
    \[ \vec{F} = m\vec{\ddot{r}} \]

\[ G = 6.672 \times 10^{-11} \text{ m}^3\text{kg}^{-1}\text{s}^{-2} \]
A Brief History of Aeronautics

Daedulus & Icarus (Greek Mythology)
Leonardo da Vinci (1452-1519)
Montgolfier Bros. (~1740-1810)
George Cayley (1773-1857)
Otto Lilienthal (1848-1896)
Samuel Pierpont Langley (1834 – 1906)
Wilbur Wright (1867 – 1912)
Orville Wright (1871-1948)
Leonardo da Vinci (1452-1519)

- The original Renaissance Man: painter, inventor, writer
- Sketched several “aerospace” vehicle concepts

Note: the King Crimson song “Night Watch” tells the story of a scandal that occurred in LdV’s life
Montgolfier Brothers
Joseph-Michael (1740-1810)
Jacques-Ètienne (1745-1799)

• Inventors of the first practical balloon

• 1782: discovered that heated air in a paper or fabric bag made the bag rise

• 1783: “flew” a sheep, a duck, and a rooster for 8 minutes; Louis XIV and Marie Antoinette were witnesses

• November 1783: first human flight
Sir George Cayley (1773-1857)

- Father of aviation
- Built his first aerial device in 1796: a model helicopter with contra-rotating propellers
- In 1804 designed and built a model monoplane glider
- In 1849 built a large gliding machine

The Cayley Medallion, depicting (left) a Monoplane Glider and (right) Lift and Drag - 1799
This illustration from Jules Verne’s *Round the Moon* (1873) shows the effects of “weightlessness” on the passengers of The Gun Club’s “bullet” capsule that was fired from a large gun in Florida.

The passengers only experienced this at the halfway point between the Earth and the Moon.

Physically accurate?
Otto von Lilienthal (1848-1896)

- Collected aerodynamic data, and emphasized that curvature of a bird’s wings is key to flight
- Made >2000 glider flights between 1891 and 1896
- Died in a glider accident in 1896
Samuel Pierpont Langley (1834 – 1906)

- Astronomer and Director of the Smithsonian, became interested in flight in his 50s
- 1903: attempted catapult-launch of gasoline-engine, piloted “aerodrome” from a houseboat in the Potomac. Failed
- Spent more than $50,000 of federal funds; was ridiculed by the press and Congress
Wright Brothers
Wilbur (1867 – 1912)
Orville (1871 – 1948)

- Wilbur was born in Indiana and Orville was born in Ohio; they grew up in Dayton, Ohio
- Designed the Wright Flyer in their bicycle shop
- December 17, 1903: first manned flight, Kitty Hawk, North Carolina
Mystery Vehicle #1

CASSINI SPACECRAFT

A journey to Saturn 15 years in the making reaches the ringed planet June 30. The U.S.-European mission involves two spacecraft — the Cassini orbiter itself and the Huygens probe. The planned 4-year mission will cost an estimated $3.27 billion.

High-gain antenna
Low-gain antenna
Magnetometer boom (36.3 feet long)
Radio/plasma wave subsystem antenna (one of three)
Cosmic dust analyzer
Remote sensing pallet
Orientation thruster (one of four)
445-newton engines (two)
Radar bay
Fields and particles pallet
Magnetospheric imaging instrument
Huygens Titan probe
Radioisotope thermoelctric generator (one of three)

SOURCE: Jet Propulsion Laboratory

SPACE NEWS GRAPHIC BY JOHN BRETSCHNEIDER, JPL SPACECRAFT IMAGE
Mystery Vehicle #2
Messerschmitt Me 262

- First operational jet-powered aircraft
- Saw action from late 1944 in both bomber/reconnaissance and fighter/interceptor roles

Blue Oyster Cult’s “Me 262” is about this airplane
Bell X-1

• First supersonic flight 14 October 1947 by Capt. Charles Yeager

• Designed for conventional takeoff, but most flights were taken to 20,000 ft on a B-29 or B-50 bomber

Length 31.00 ft (9.45 m)
Wingspan 28.00 ft (8.53 m)
Height 10.85 ft (3.31 m)
Wing Area 130.0 ft\(^2\) (12.01 m\(^2\))
Max Takeoff 13,400 lb (6,080 kg)