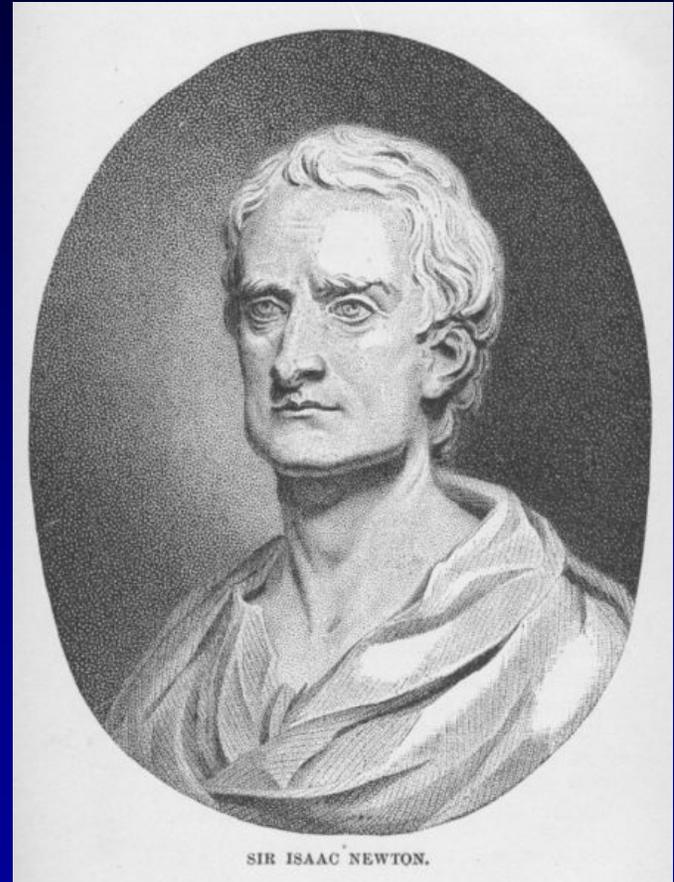


Tonight's 'History of Astronomy' topic is:

Isaac Newton

Father of Modern Science



Compiled by Jim Wessel
Johnson Space Center Astronomical Society

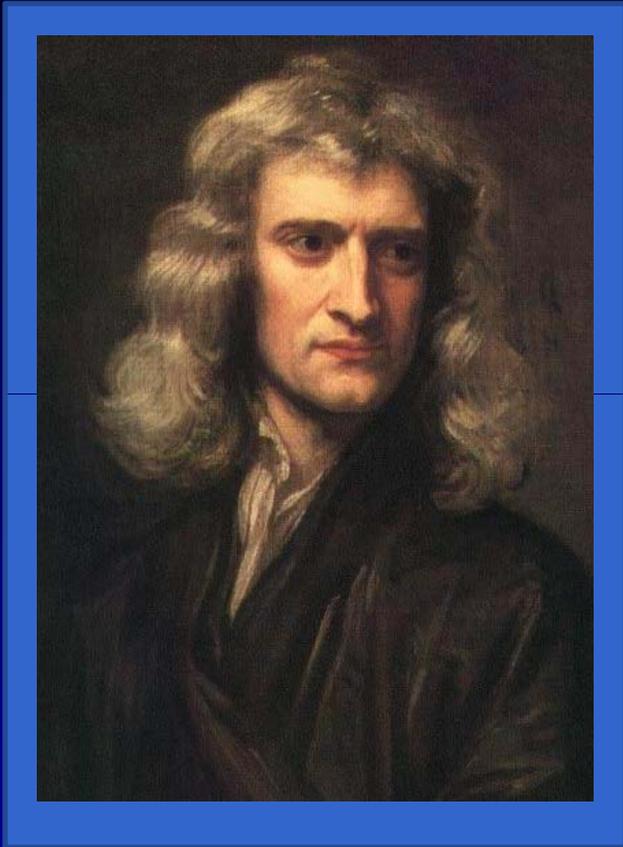
Isaac Newton

- He was born January 4th, 1642 in Woolsthorpe-by-Colsterworth.
- Isaac's father died before his birth.
- His mother was Hannah Ayscough – remarried to Rev. Barnabus Smith in 1646.
- Newton lived with his grandmother, Margery Ayscough, until his re-widowed mother returned to Woolsthorpe in 1653.
- When he turned 12, Isaac was sent to The King's School in Grantham.
- In 1659, (at 15 yrs old), he was taken out of school and was expected to become the lord of the manor – but he wasn't a good farmer.



Woolsthorpe Manor

Isaac Newton



- At 17, he returned to school and became the top ranked student, and soon graduated.
- 1661 – Newton was admitted to Trinity College, for training for the clergy.
- He preferred studying modern (his current day) philosophers and astronomers.
- In 1665, his mathematical skills really developed, started concepts of Calculus.
- Also in 1665, graduated from college, had to leave university - plague was rampant.
- At home, he developed his theories of optics, gravitation and furthered his thoughts on Calculus. More on that in a bit.

Isaac Newton

- While at home Newton was said to observe an apple falling from a tree, and that was the impetus for him to describe the Law of Gravitation.



Possible descendant tree from Newton's own garden.

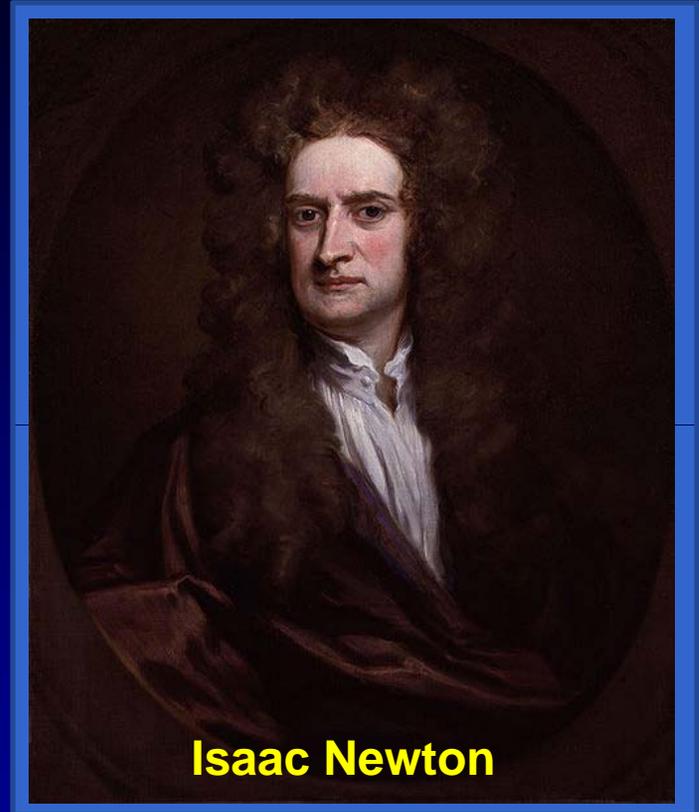
The Father of Calculus?



- First published, in 1684.



- Newton derived his method years before Leibniz.



- Finally published in 1693, final version in 1704.
- Many different Newtonian contributions.
- Appointed the Lucasian Professor of Mathematics at Cambridge in 1669.

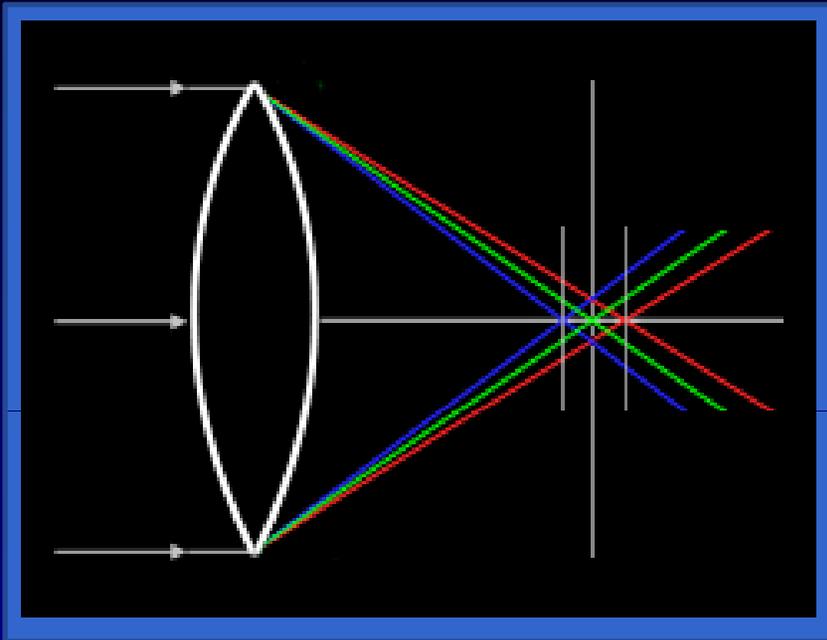
Isaac Newton

- At Cambridge, Newton first sought to understand Optics.
- He examined Light Refraction, the separation and recombination of light through prisms.
- He projected colored light onto other objects – became the basis of Newton's Theory of Color. It states:



The color of objects is a feature of the light projected onto them rather than the objects producing a color themselves.

Isaac Newton



- Studying refraction made Newton understand the concept of chromatic aberration.

Chromatic aberration is when light passes through a lens and the component colors come to focus at different distances. You end up getting a colored halo around celestial objects.

- To alleviate this constant problem, Newton designed a brand new kind of telescope – one that relies on reflection.
- He presented this new design to King Charles II and the Royal Society of London in 1762.



Today's Newtonian Style Telescopes



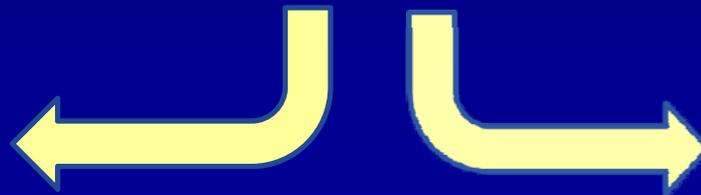
True
Newtonian
reflector

Schmidt-Newtonian,
notice the corrector
plate on the front.



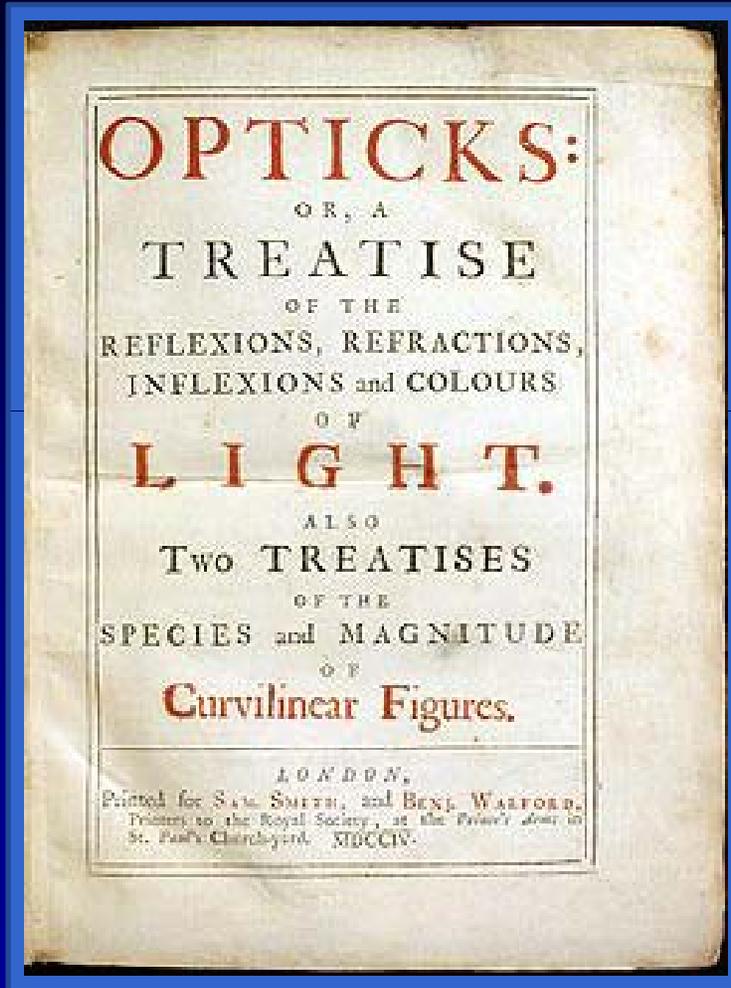
Basic design,
changed to make

Dobsonian mounted,
Newtonian reflector



Isaac Newton

Newton's concept of Light

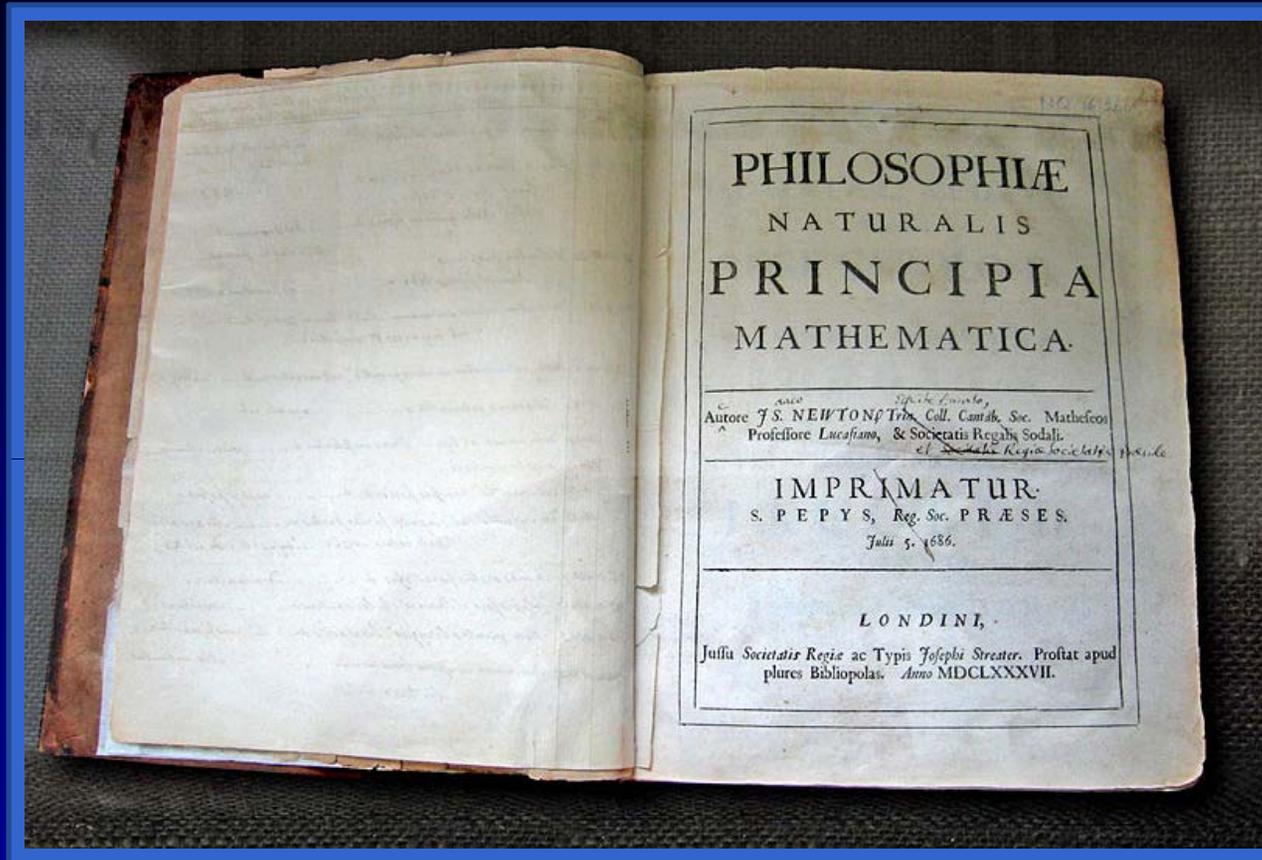


- Under the condition of:

Refraction = Light is made up of particles – Corpuscles, that bent towards a denser medium.

Diffraction = Light moves in a wave-like motion.
- First published in 1672 in the Royal Society's *Philosophical Transactions*.
- Robert Hooke and Christaan Huygens disagreed with the principles – As a result Newton vowed never to publish again.
- The final version of Newton's particle theory of light – *Opticks*, published 1704.
- Modern theory of light replaces most of Newton's ideas.

Isaac Newton



- In 1677, Newton started his work on Mechanics.
- On July 5th 1687, the *Philosophiæ Naturalis Principia Mathematica* was published.
- In it, Newton describes his three universal laws of motion, the universal law of gravity, and determined the speed of sound in air.

Law of Universal Gravitation

$$F = G \frac{m_1 m_2}{r^2}$$

Where:

F is the magnitude of the gravitational force between the two masses,

G is the gravitational constant,

$$G = (6.67426 \pm 0.00067) \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$$

m_1 is the mass of the first point mass,

m_2 is the mass of the second point mass, and

r is the distance between the two point masses.

Isaac Newton

- Newton's First Law:

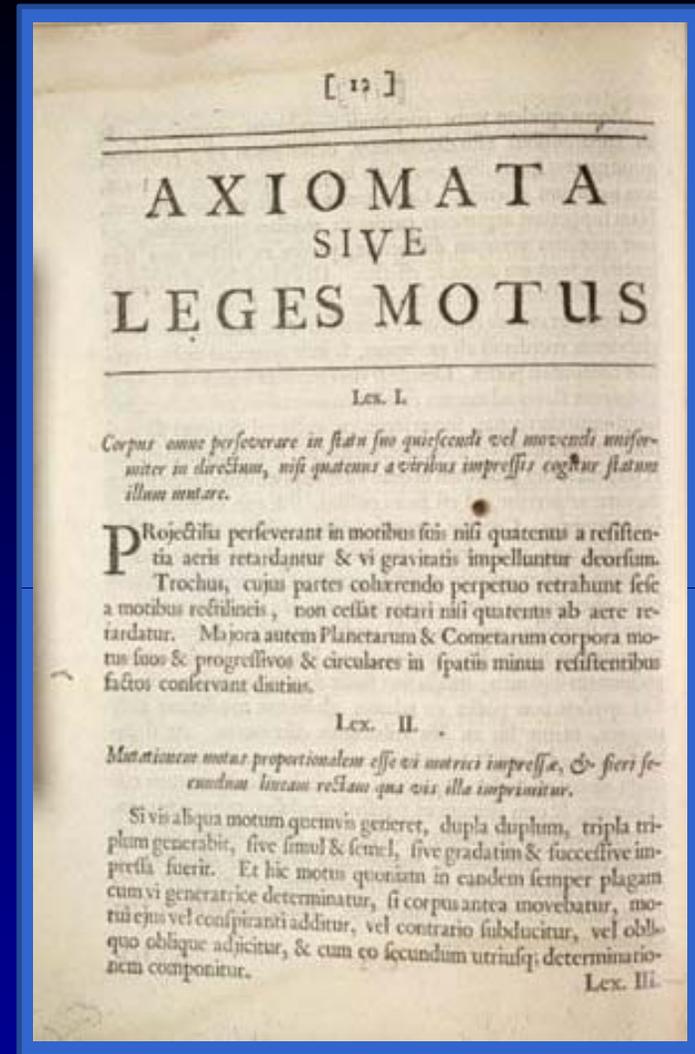
Lex I: Corpus omne perseverare in statu suo quiescendi vel movendi uniformiter in directum, nisi quatenus a viribus impressis cogitur statum illum mutare.

An object at rest remains at rest, and an object in motion remains in motion, unless acted on by an outside force.

- Newton's Second Law:

Lex II: Mutationem motus proportionalem esse vi motrici impressae, et fieri secundum lineam rectam qua vis illa imprimitur.

Force equals mass times acceleration ($F = ma$): the net force on an object is equal to the mass of the object multiplied by its acceleration.



Isaac Newton

- Newton's Third Law:

Lex III: Actioni contrariam semper et æqualem esse reactionem: sive corporum duorum actiones in se mutuo semper esse æquales et in partes contrarias dirigi.

For a force there is always an equal and opposite reaction: or the forces of two bodies on each other are always equal and are directed in opposite directions.

- The publication of the *Principia* awarded Newton with international fame (in contrast to his work on optics).
- The SI unit of force is the Newton:

$$1 \text{ N} = 1 \text{ kg} * \text{ m/s}^2$$

Isaac Newton



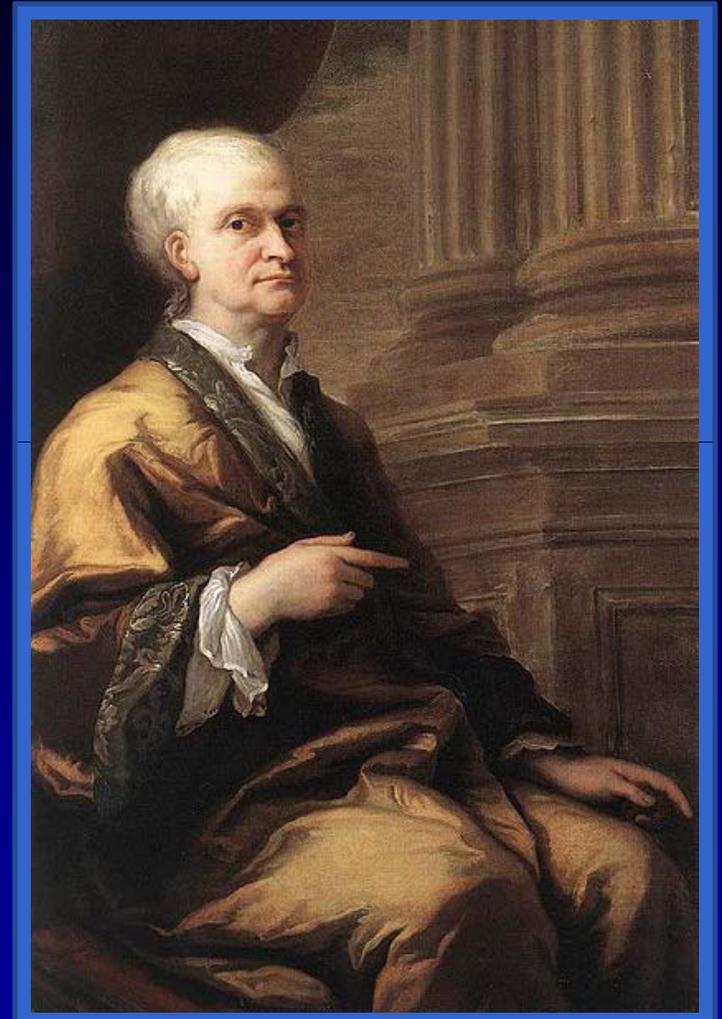
Isaac Newton as a person:

- Moderate height, increasingly stout with age.
- Kept his eyesight throughout his life.
- Simple tastes.
- His style matched the occasion.
- Truly able to focus his thinking.
- Ambitious, a little suspicious of others.
- Enjoyed adulation, was somewhat short tempered.
- Don't get on his bad side...
- Bachelor – no Children.

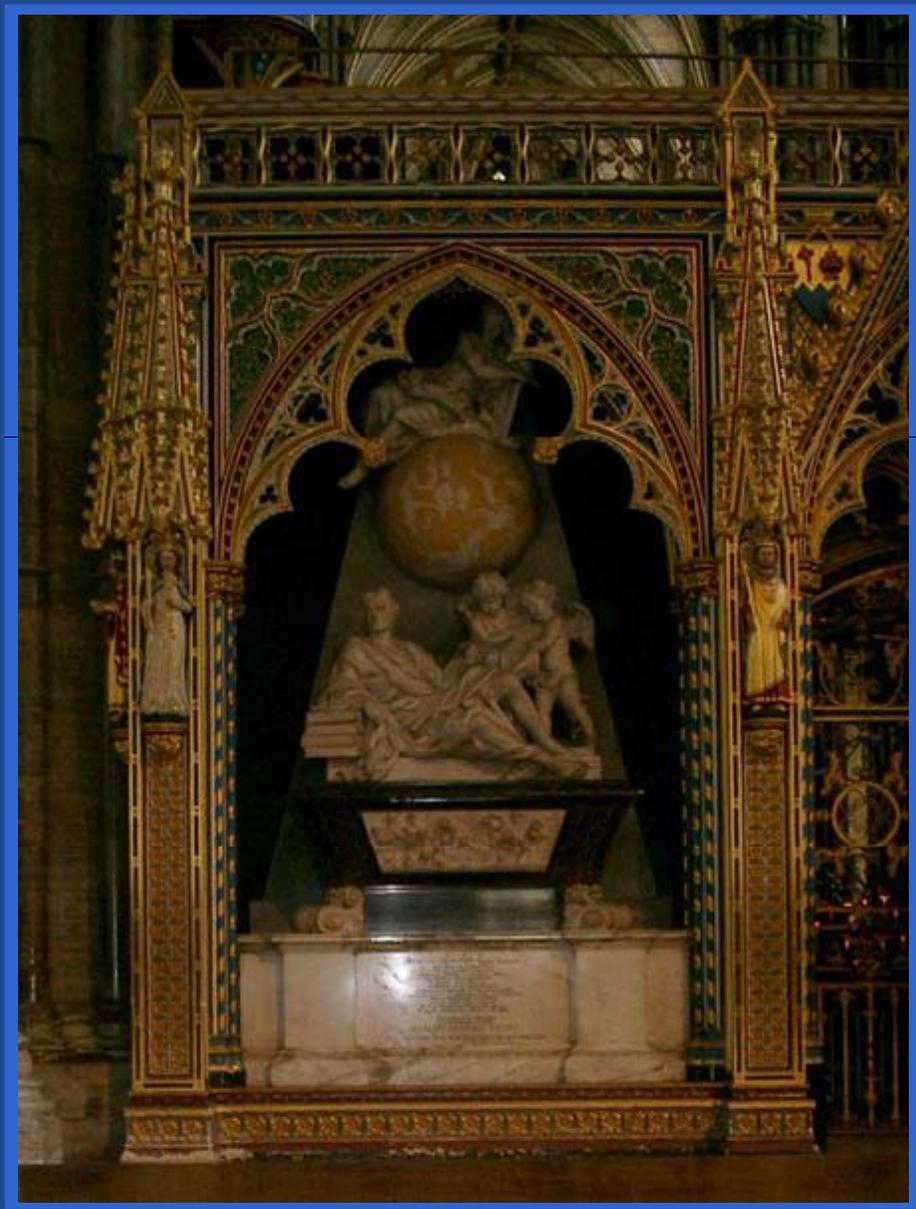
Isaac Newton

Later in Life, Newton –

- Wrote philosophical translations of his views of the Bible.
- Was elected to Parliament.
- Appointed to be a warden for the Royal Mint – 1696. Became the Mint Master in 1699.
- Elected President of the Royal Society of London in 1703.
- First scientist to be knighted.
- Unknown to most, Isaac Newton was serious and dedicated alchemist.



Isaac Newton



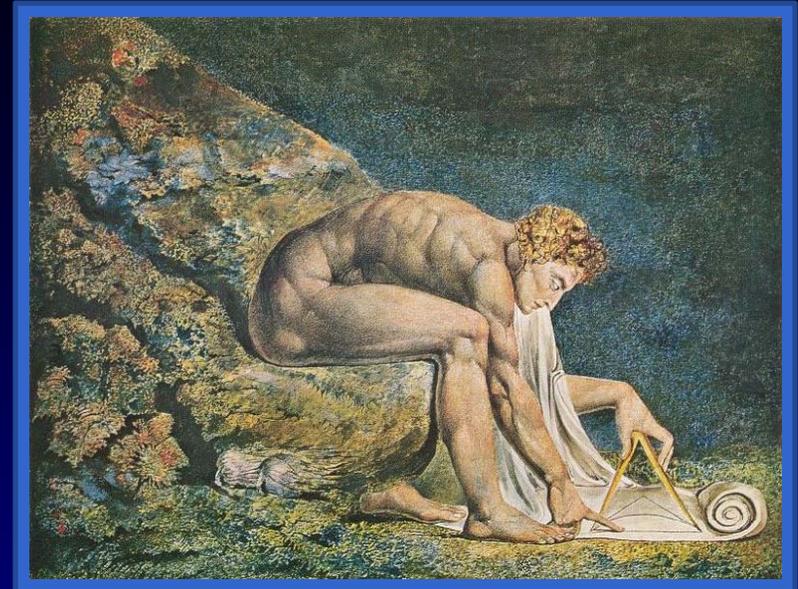
- He died at the age of 84 on March 31st, 1727, in London.
- Was given a state funeral.
- Entombed in an ornate sarcophagus in Westminster Abbey.

Isaac Newton

“Newton” by William Blake, 1795

Quotes attributed to, or written about
Newton:

*“Nature and nature’s laws lay hid in night:
God said “Let Newton be” and all was light”*
- english poet Alexander Pope



Newton said, *“If I have made any valuable discoveries, it has been owing more to patient attention than to any other talent.”*

Newton also said, *“Gravity explains the motions of the planets, but it cannot explain who set the planets in motion. God governs all things and knows all that is or can be done.”*

Also attributed to Newton is, *“If I have seen further it is by standing on ye shoulders of Giants.”* - Was this an insult to Robert Hooke?



Robert Hooke

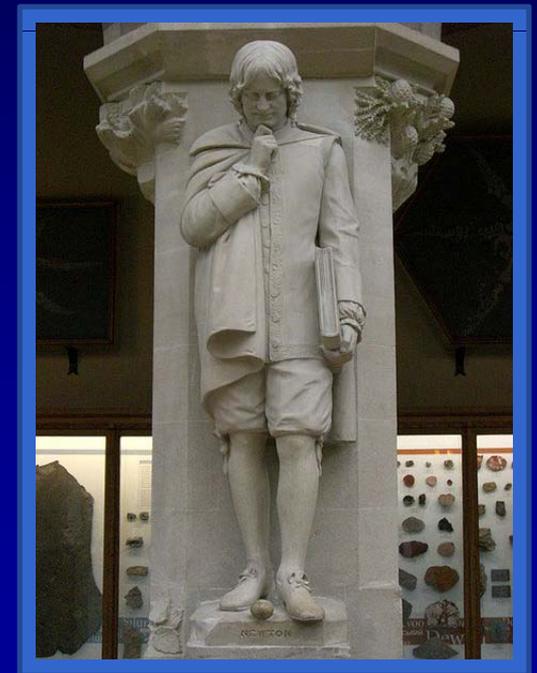
Isaac Newton



- Newton was featured on the back of the one pound note, for 10 years (1978 – 1988).
- Closing thoughts...

Sources for this presentation:

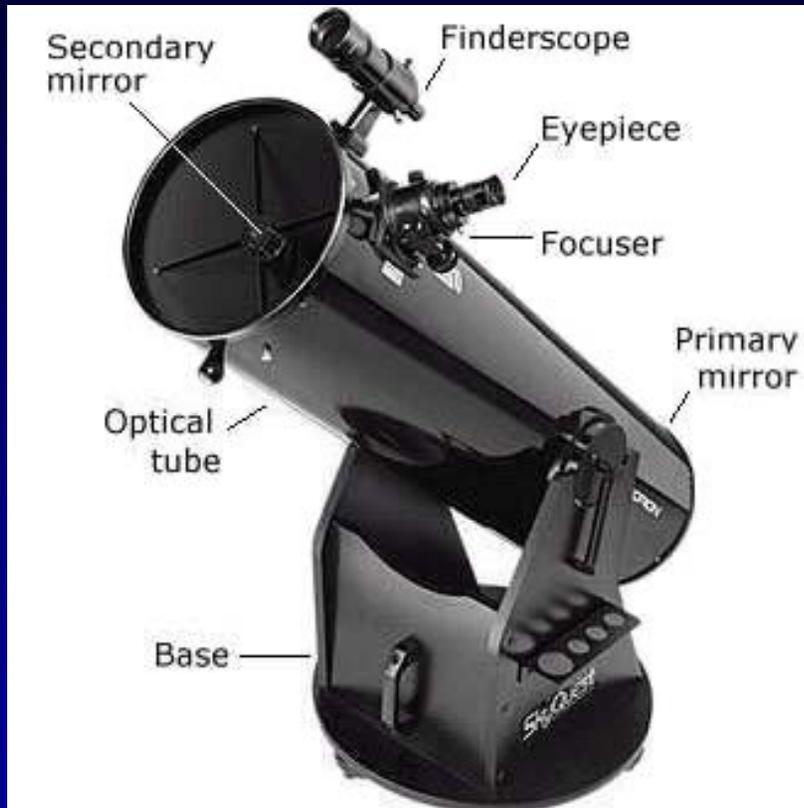
Wikipedia, Scienceworld.wolfram.com, Blupete.com, Britannica.com, and the Isaac Newton Institute for Mathematical Sciences.



Statue of Newton at the Oxford Univ. Museum of Natural History

Additional slides on the
advantages and
disadvantages of Newtonian
style telescopes.

Newtonian Telescopes



Advantages:

- Free of chromatic aberration found in less expensive refracting telescopes.
- Less expensive on basis of aperture than other quality scopes of different designs.
- Construction is easier than for catadioptric telescopes (Schmidt-Cassegrains, Maksutovs).
- Capable of extremely wide fields of view, due to short focal length.
- Design can allow for compact mounting (dobsonian).

Newtonian Telescopes



Disadvantages:

- Short focal length Newtonians suffer from coma (off axis aberration). $f/6$ and longer focal ratios are generally free of this.
- They have a central obstruction (the spider and the secondary mirror).
- Collimation can sometimes be an issue.
- Cheaper Newtonians can have poor optical quality due to use of a spherical mirror rather than a parabolic mirror. This is not typically a problem at $f/10$ and greater focal ratios.