

The Universe

Video Outline

Episode Title: *Beyond the Big Bang*

Length: 1:30

Humans have been observing the heavens for thousands of years

Big Bang Theory

Proposed to explain the formation of the universe

Realization that everything was speeding apart intuitively led to thoughts of an explosion

Today it is the benchmark of cosmology

Generally only discusses what occurred AFTER the event

Expanding Universe

Contains an estimated 125 billion galaxies
13.7 BYBP, universe was subatomic in size

Primitive Man

Tried very early on to make sense of the Heavens

Ancient sites are found the world over

Oldest known European “calendar” is 7000 years old

Astronomy and astrology naturally got intermixed

Astrology unintentionally led to legitimate astronomy

Caused “bad science” as well

Earth was believed to be “fixed” as the center of the universe

Greeks

Figured the Earth was curved and calculated its correct size along with the Moon

Noted distinction between stars and planets

Aristotle - Geocentric model and celestial sphere explanation of the universe

Ptolemy - Accurately traced the path of the planets (actual movement was wrong)

Dark Ages

Much “wisdom” was lost and incorrect models lasted for centuries

13th Century

Copernicus

Heliocentric model appears

Catholic Church viewed heliocentrism as a threat

Copernicus realized Ptolemy’s error and resolved solution through heliocentrism

Copernicus also believed in Earth’s rotation to explain nighttime star movements

Withheld publishing models until 1543 upon deathbed for fear of reprisal

Kepler

Born 1571

Championed heliocentrism

Also realized planetary orbits were ellipses rather than circles

Theorized about variable speed planetary orbits

Realized the Sun was the key but force unknown

Galileo

17th Century

Used telescope to make observations

Observed Jupiter’s moons, Moon, deep space stars, “ears” of Saturn

Phases of Venus PROVED heliocentric model

Galileo essentially PROVED all earlier astronomic models

Galileo published findings in 1610

Catholic Church eventually condemned

Galileo and charged him with heresy in 1633 after interpreting Scripture with regard to his observations

Shortly before his death, Galileo theorized about gravity but did not understand the significance

Newton

Born 1643

Brought Galilean and Keplerian ideas together to explain the universe
Essentially proved the existence of gravity through mathematics
Newton effectively CREATED physics
Newton's laws basically explain the nature of the universe itself
Never explained WHY gravity works

Albert Einstein

Born 1879

Was a proponent of an infinite universe but realized that the properties of gravity supported finite universe
1905 - Theory of Special Relativity - Suggests "Space Time"
1915 - Theory of General Relativity - Adds the effects of gravity to Space Time
1919 - Solar eclipse was observed in order to see if Space Time could be "warped" by a massive body as suggested by Einstein - YES
Realized that his belief in a Static Universe was incorrect - If universe was static, all mass would eventually gather together in one place
Leads to an idea that a force acting against gravity existed

Georges LeMaitre

Ironically a Catholic Priest
Suggested the universe was "born"
Studied Einstein's work and theorized the universe was expanding and was therefore infinitely small
Believed the universe evolved from a "primeval atom"
Pope used LeMaitre's observations to "prove" Genesis - LeMaitre openly disagreed

Hubble

Observed the Sun was one of billions
First observed the Milky Way galaxy but then saw other galaxies as well
Realized galaxies were moving apart by measuring their Doppler shift

Based upon speed of galaxies, he mathematically calculated age of universe - math was correct, observations were inaccurate

Fred Hoyle

Steady State Theory - Stated that every element after helium was formed by fusion within stars - could not explain H or He
H and He were believed to be present in an infinite universe
Marketed his ideas on the radio and won much support
Actually coined "Big Bang" out of sarcasm in 1949

George Gamow

Disagreed with Hoyle and extended LeMaitre's ideas
Believed H and He were created in the opening moments of the universe when temperatures were insanely high

Ralph Alpher and Robert Herman

Students of Gamow
Refined LeMaitre's belief that residual heat from the Big Bang should be detectable
Eventually called the Cosmic Background Radiation
Technology not present to observe

Robert Dicke (Princeton)

Supported LeMaitre and wanted to search for residual radiation from Big Bang
Eventually coordinated (by accident) with Bell Labs physicists working on telecommunications

Arno Penzias and Robert Wilson

Worked for Bell Labs and detected "static" noise during satellite telecomm. testing - could not explain source - originated "everywhere"
Once linked with Princeton team, realized they had detected energy from the Big Bang effectively proving the

theory

Problems with Big Bang Theory

Temperatures in space are uniform -
universe is just too large for this to
have occurred - universe is too young
to be uniform temperature

Alan Guth

Theorized universe was very small at one
point and may have cooled uniformly
before it expanded to much

Inflationary Universe Theory

Considered the four forces of the
universe were merged into one
“superforce” which expanded so fast
that uniformity was “locked in”

WMAP Mission (2001)

NASA mission to photograph the actual
Cosmic Background Radiation
2003 - Imagery within 285K years from Big
Bang
Patterns strongly supported Guth’s ideas

Big Bang Sequence of Events

<Billionth of a second - universe is
subatomic in size - held together by
Superforce
Gravity splits first and Superforce decays
into four known forces releasing
burst of energy which locks in
uniformity of universe and causes
hyperinflation
~3 minutes - temperature is near 1 billion
degrees, H nuclei form along with
some He
~380K years later - light released creating
the Cosmic Background Radiation
~1 billion years - stars/galaxies form and
fuse heavier elements like N, O, C,
etc. Planets form in circumstellar
disks
~9 billion years - the Sun forms
~13.7 billion years - universe is 156 billion
light years across and humans
theorize about their own existence

Dark Energy and Big Rip Theory (2003)

Universe is accelerating in its expansion rate
but can not be explained by the
known mass of the universe - dark
matter must be contributing
Big Rip suggests that eventually, expanding
universe will reach a size where
gravity will no longer be able to hold
it together and even atoms will fly
apart