The Universe Does Not Revolve Around You
Week 3

Capilano University Campus
Jan 27th, Feb 3rd, Feb 10th

Presented by Michael Bradley

www.sunmoonstars.ca/eldercollege

The Universe does not revolve around You

- Week 1
  - Opening Discussion
  - Cosmologies of the Ancient World
  - Greek Philosophers and the "Crystal Sphere"
  - The spread of the Aristotelian *"geocentric"* view
  - Video – "*Earth Views*"
  - Video – "*No! You are not the centre of the Universe*""
- Week 2
  - The Abrahamic faiths
  - Copernicus and the *"heliocentric"* view
  - Medieval & Renaissance society
  - Galileo and the Vatican
  - Video -"*Our Solar System*"
  - Video – "*Venus Transit*"
- Week 3
  - The Newtonian Universe
  - The "Enlightenment" – 17,18 cent.
  - The "Modern" Period
  - The Overview Effect
  - Does the Universe have a "centre"?

Where earth and sky meet

“A missionary from the middle ages tells that he had found the point where the sky and the earth touch”

“Empedocles Breaks through the Crystal Spheres”
Camille Flammarion, *L'atmosphère: météorologie populaire* , 1888)

Review of Week 2

- We saw how the “Aristotelian” view of a geocentric Universe proved very resistant to alternative views.
- We saw how the “Aristotelian” cosmological view was reconciled with the Christian Biblical view.
- We saw how the belief that “everything has its naturally defined position” reinforced social mores.
- By the end of Week 2, earth was no longer at the centre of our Universe, the sun was. The “Crystal Spheres” had been shattered.
- Dogma’s being questioned, Revolution was in the air!

An Ideological Revolution

- The worlds of the values and meanings were now becoming recognised as separate domains.
- Many people, impressed with the success of the sciences, were no longer taking the authority once held by religion or royalty for granted.
- However the science did leave many unanswered questions & astrology started to gain wider support.
- The justification for the hierarchy of the church or the divine rights of kings was questioned. Soon kings in England & France were losing their heads.

Source: Primack & Abrams

The *"Cartesian Bargain"*

The “Cartesian Bargain”

- Publication of *“Dialogue concerning the two chief world systems”* in 1632 marked the start of a tremendous shift in cosmology.
- The Catholic Church had certainly tried to suppress these new ideas, and Galileo had agreed to remain silent. The church was ultimately unable to halt the revolution now underway though.
- It is remarkable that in their attempt to prove heresy against Galileo the Inquisition had used Aristotle as their “bible”, not the actual Bible! Evidence of how established his cosmology was.

The “Cartesian Bargain”

- What followed was an unwritten truce between science & religion, the “Cartesian Bargain”.
- The church abandoned its claim to have scientific authority and scientists agreed not to try to influence religious doctrines.
- The church did however continue its own lines of scientific enquiry, (i.e. the Jesuit order in particular produced many notable scientists, and the Vatican Observatory.)
- The church did revise its teachings sometimes as evidence emerged, (ie no longer teaches about a 6000 yr earth).

Source: Primack & Abrams

John Donne (1572-1631)

- The foremost preacher of the time, initially a Catholic, later converting to Anglican (under duress).
- Well known at the time as a poet.
- His friends and acquaintances included Kepler and the physician William Harvey.
- He was aware of Galileo's discoveries and Tycho's new star.
- Many of his poems show a keen awareness of the current issues in the field of "natural philosophy".

An Anatomy of the World
John Donne

And new philosophy calls all in doubt,
The element of fire is quite put out,
The sun is lost, and th'earth, and no man's wit
Can well direct him where to look for it.
And freely men confess that this world's spent,
When in the planets and the firmament
They seek so many new; they see that this
Is crumbled out again to his atomies.
'Tis all in pieces, all coherence gone,
All just supply, and all relation;
Prince, subject, father, son, are things forgot,

The First Anniversary, lines 205-215, 1611

John Donne (1572-1631)

- This poem had been written on the occasion of the death of a daughter and has a pessimistic tone as far as the state of the world is concerned.
- The recent attempts to advance our understanding of the natural world seem to Donne to be unhelpful and contributing to human despair.
- He wrote this at a time where the heliocentric universe had been revealed, where earth had been *"shot into the heavens"* and new planets and stars added. A cosmological *"no-man's land".*

(Literary Londoners, Gresham College 1995, Dr. J.V.Field, , John Donne and New Philosophy)

John Donne (1572-1631)

- In a poetic, but essentially accurate, portrayal of the tension that existed between the old and new ways of viewing the Universe he wrote:

(Literary Londoners, Gresham College 1995, Dr. J.V.Field, , John Donne and New Philosophy)

John Donne (1572-1631)

We think the heavens enjoy their spherical,
Their round proportion, embracing all;
But yet their various and perplexed course,
Observed in divers ages, doth enforce
Men to find out so many eccentric parts,
Such diverse downright lines, such overthwarts,
As disproportion that pure form; it tears
The firmament in eight-and-forty shares,
And in these constellations then arise
New stars, and old do vanish from our eyes;
As though heaven suffered earthquakes, peace or war,
When new towers rise, and old demolish'd are.

The First Anniversary, lines 251-261, 1611

John Donne (1572-1631)

- After converting to Anglicanism, Donne wrote several anti-Catholic tracts and poems, many of which caricatured the anti-Copernican arguments.
- In one, “Ignatius his Conclave”, he directs his satire at Ignatius Loyola, founder of the Jesuits. Loyola is in a competition to be the devil’s best ally.
- Copernicus is in the competition too, for his heliocentric view which is contrary to scripture, common sense & morals. By putting earth in motion among the stars, he has thwarted God’s purpose by elevating the status of Lucifer’s prison (earth).

The Seventeenth Century

- The telescope, microscope, thermometer, barometer, precision clock, were all seventeenth-century inventions that were revolutionizing the understanding of the natural world.

- It wasn't only the poets who were aware of and alarmed by these developments.

Philosophers

Blaise Pascal (1623-1662)

- The French physicist-mathematician, philosopher and monk, Blaise Pascal, absorbed this post-Galileo picture, reported experiencing a cosmic malaise:

  "I feel engulfed in the infinite immensity of spaces whereof I know nothing and which know nothing of me. I am terrified.... The eternal silence of these infinite spaces alarms me."

- Pascal felt tossed into a "scientific" universe that was cold, shapeless, and incomprehensibly huge, in which humans were rootless & insignificant. This impression of the universe has persisted for many.

Bernard de Fontenelle (1657-1757)

- French author and influential member of three of the academies of the Institut de France, noted especially for his accessible treatment of scientific topics during the Age of Enlightenment.

  "Behold a universe so immense that I am lost in it.

  I no longer know where I am.

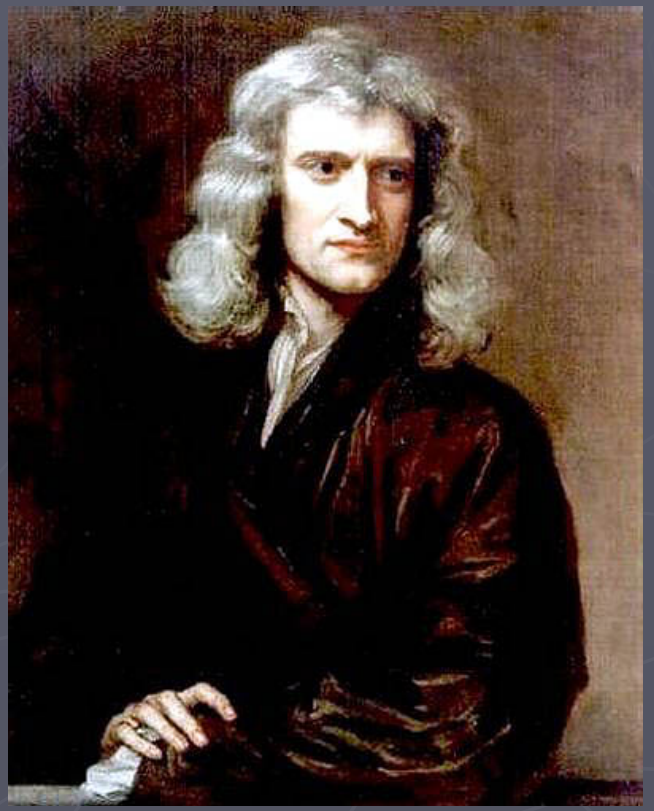
  I am just nothing at all.

  Our world is terrifying in its insignificance."

Sir Isaac Newton

Sir Isaac Newton (1642-1727, England)

- Not expected to live at birth... instead he lived 84 years.
- Served as England's "Master of the Mint".
- Knighted in 1705, the first scientist to receive the honour.
- He made MANY contributions to science ...



Newton's Contributions

- He laid the foundations for the calculus (age 23!)
- Demonstrated that "white light" can be broken down into the colors of the rainbow using a prism (age 30)
- Invented the reflecting (mirror-based) telescope, a great improvement over earlier refracting (lens-based) telescopes
- A staunch defender of academic freedom.

Newton's Laws of Motion

- Newton is known for developing his 3 Laws of Motion. These were derived from Kepler's 3 Laws.
  - 1st Law – An object at rest will stay at rest, and an object in motion will stay in motion at constant velocity, unless acted upon by an unbalanced force.
  - 2nd Law – Force equals mass times acceleration.
  - 3rd Law – For every action there is an equal and opposite reaction.

Newton's Laws of Gravitation

- Newton is also known for developing his Law of Gravitation.
- He argued that all bodies attract each other through the force of gravity and that the strength of that force drops off with distance squared.
- This remains one of the most powerful ideas of physics, holding true even today for motions well short of the speed of light, NASA use it every day!
- He had to be persuaded by members of the Royal Society to publish his findings though!

Newton's Apple

"Why should that apple always descend perpendicularly to the ground" he thought to himself.

"The reason is that the Earth draws it.... And the sum of the drawing power must be in the earths centre.

If matter thus draws matter, it must be in proportion of its quality. Therefore the apple draws the Earth, as well as the Earth draws the apple."

William Stukeley, friend of Newton's

The *Principia* - *1687*

- In the 3 books of the *Principia*, Newton states his laws of motion and of universal gravitation.
- It also included a mathematical derivation of Kepler's laws of planetary motion (which Kepler first obtained empirically).
- The *Principia* is regarded as one of the most important works in the history of science.

The *Principia* - *1687*

- Newton described a universe that was:
  - Infinite
  - Matter was uniformly distributed
  - The Universe is gravitationally balanced
  - The same laws work everywhere (– since the Greeks the laws of the cosmos had been held to be different from those on earth)
- The Universe that Newton described was basically right (but not infinite), on the scale of the Solar System (sun, planets, moons).
- It works when sizes aren't too large, speeds too fast and gravitational forces too high.

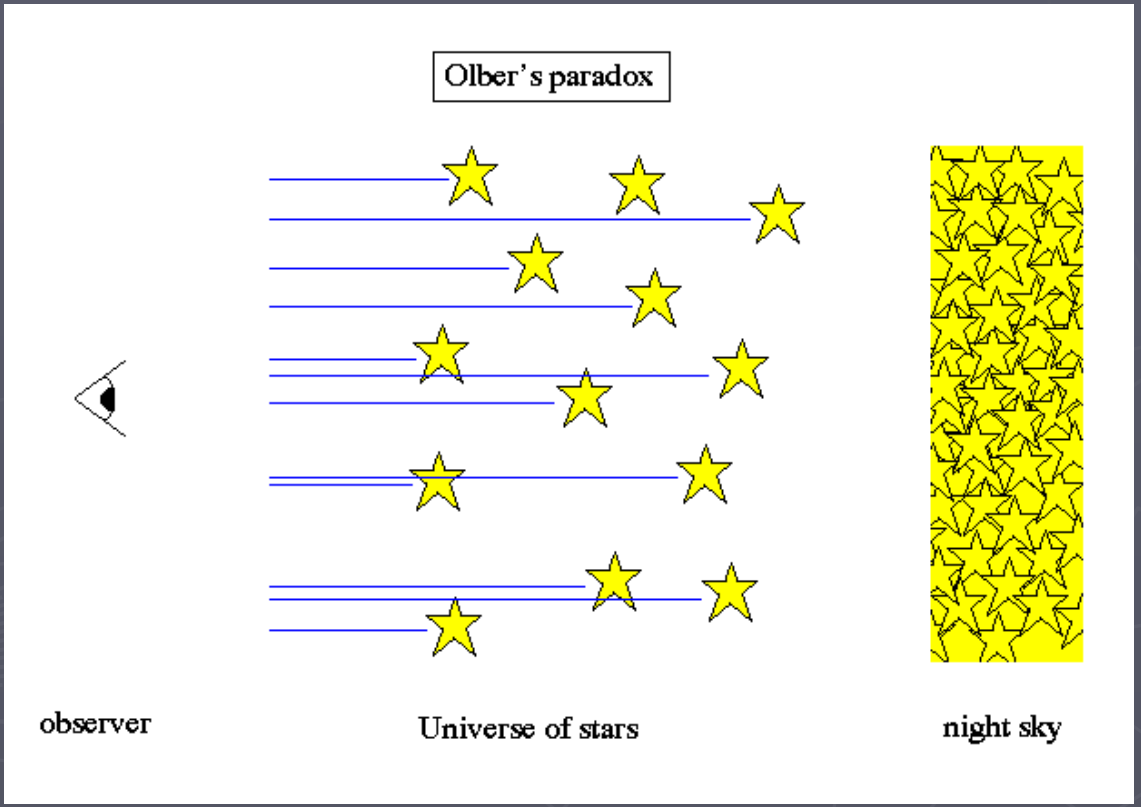
The *Principia* - *1687*

- He argued that if the Universe was finite, gravity would pull everything to the centre, therefore it was probably infinite.
- But if the universe was infinite and matter was distributed evenly, why is the night sky dark?
- If you look out along any line of sight into an infinite universe, you must see a star. Far away stars will be fainter, but there will be more of them.
- The sky should be as bright as an average star, even at night!

Olbers Paradox

There will be a tree in every line of direction
if the forest is sufficiently large.

Olbers Paradox



There will be a star in every line of direction if the universe is infinite.

Olbers Paradox

- What is the answer to the paradox?
  - Today we know that the universe is not infinite.
  - The Universe is expanding.
  - It has not existed forever (13.7 billion years).
- The “Big-Bang” theory ultimately explained Olbers’s paradox with the finiteness of the lifetime of the Universe and hence of its stars.
- In fact the sky is ablaze, but the temperature of the radiation is only 2.7 ^{o}K (Cosmic Microwave Background Radiation), and hence invisible to our eyes.

Newton's epitaph

- *"Nature and Natures laws lay hid in night;*

  God said 'Let Newton be' and all was light"

Alexander Pope

The Newtonian Universe

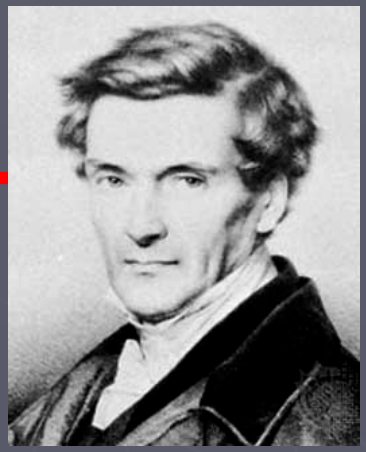
- The Universe is now an endless, empty space with randomly scattered stars.
- The Universe must be very, very large otherwise the stars would collapse in on one another.
- There was no special place for humans.
- There was no special place for God.
- There was no explanation of where the universe came from.
- For the first time the prevailing cosmology could offer no guidance to humans on how to live their lives.

Does the Earth Move?

Does the Earth move?

- None of the observations or the theoretical work actually proved that the Earth moved. A rotating and orbiting earth seems to disagree with the senses.
- If it moved, then closer stars should be seen to "jump" back and forth against more distant "background" stars over six months.
- Geocentric models, with a stationary earth, could be created that made accurate predictions, though not parsimoniously.
- This lack of proof was the main scientific criticism of the heliocentric model.

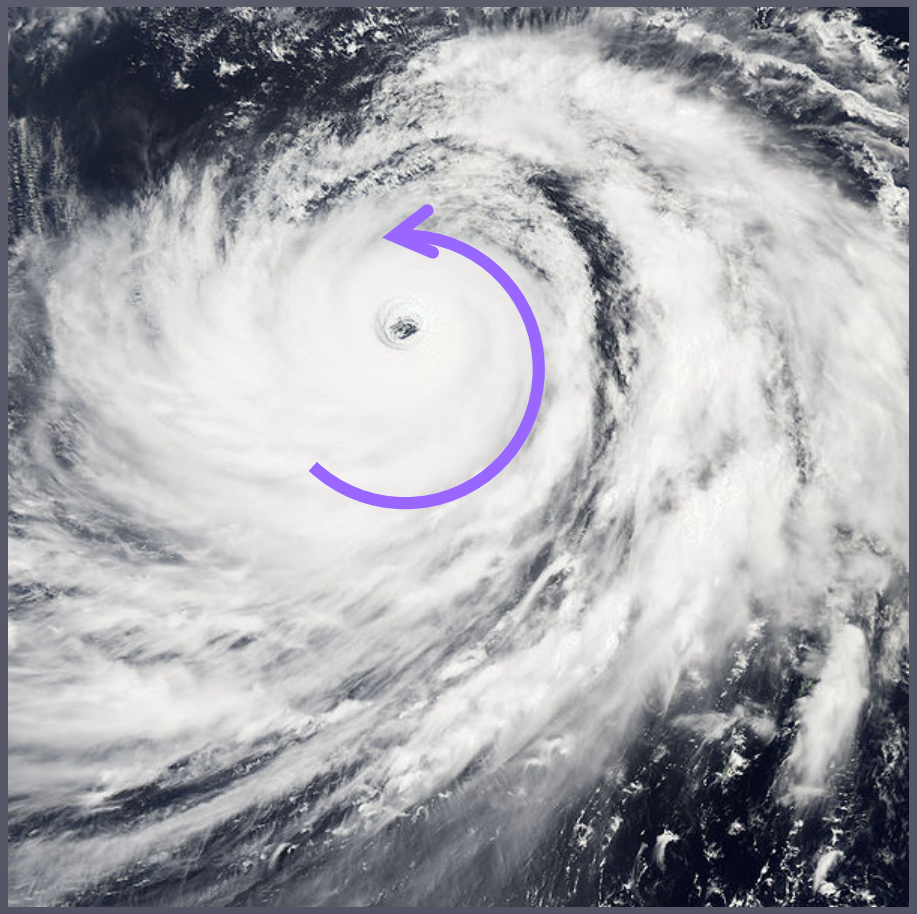
Coriolis Force



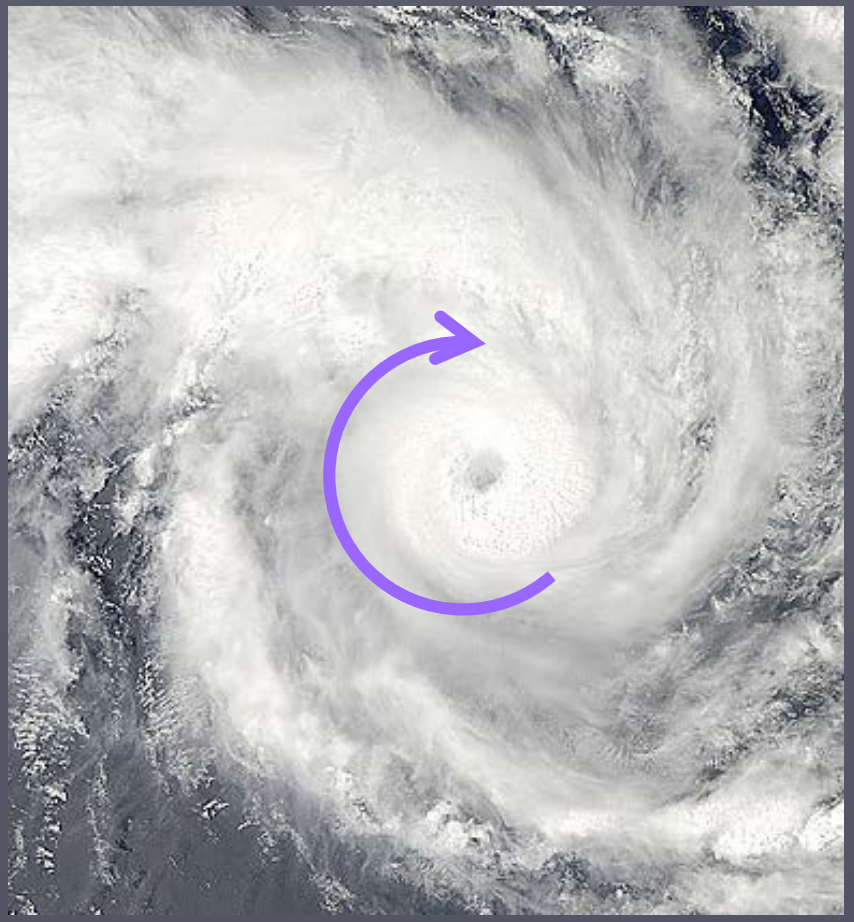
- Gustave Coriolis (1792 –1843)
- Deflection due to Earth's Rotation:
  - Fire a cannonball North from the Equator
  - The cannon is moving east with the Earth's rotation at 1670 km/hr
  - As it flies North, the Earth's rotation is *slower* beneath its flight.
- Result: a slight *eastward* deflection from its original northward trajectory.

A little to the right (or left)…

- The result of the Coriolis force is:
  - Projectiles swerve *right* at northern latitudes
  - Projectiles swerve *left* at southern latitudes.
- Long-range artillery and guided missiles are designed to correct for the Coriolis force.
- Also affects weather systems:
  - Hurricanes rotate *counter-clockwise* in the Northern Hemisphere.
  - Cyclones rotate *clockwise* in the Southern Hemisphere.



Typhoon Nagi
(North)



Tropical Cyclone Edzani
(South)

ftp://ftp.astronomy.ohio-state.edu/pub/jaj/a1143/sp14lect6.ppt

Flushing an Urban Legend

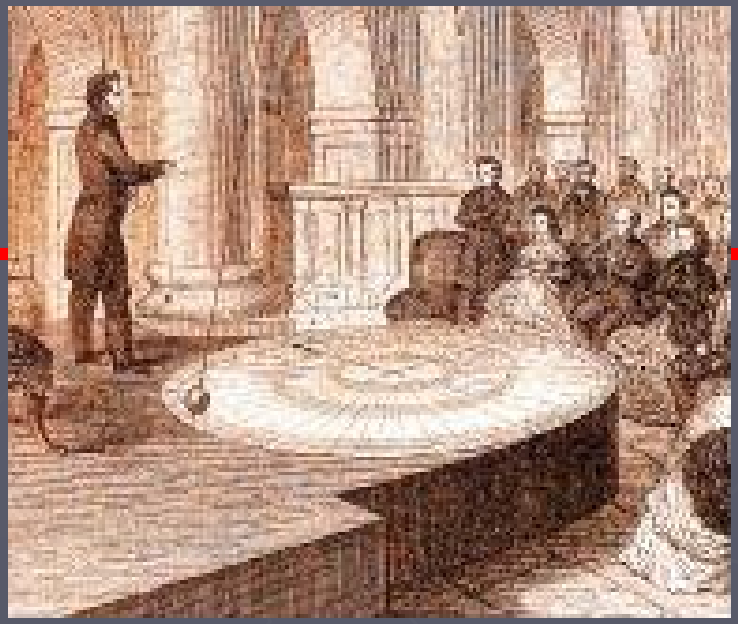
- The Coriolis force does not determine the direction water swirls down drains (or toilets)
  - Size of a sink, tub, toilet, etc. is too small
  - Coriolis effect is much smaller than other motions, (water jets, swirling with hands)
- Toilets do not flush clockwise in the Southern Hemisphere!.

Foucault Pendulum

- Built by Léon Foucault in 1851.
- Hung a 67-meter pendulum inside the dome of the Paris Pantheon.
  - Started it swinging North-South
  - A few hours later, it was swinging NE-SW
  - Later it was swinging East-West.
- The change in the direction of the swing was due to the rotation of the Earth.
- At poles 1 rotation takes 24 hrs, at the equator the earth does not rotate so there is zero rotation. (act.α)

Foucault's pendulum HSBC Vancouver

Source YouTube

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23
22
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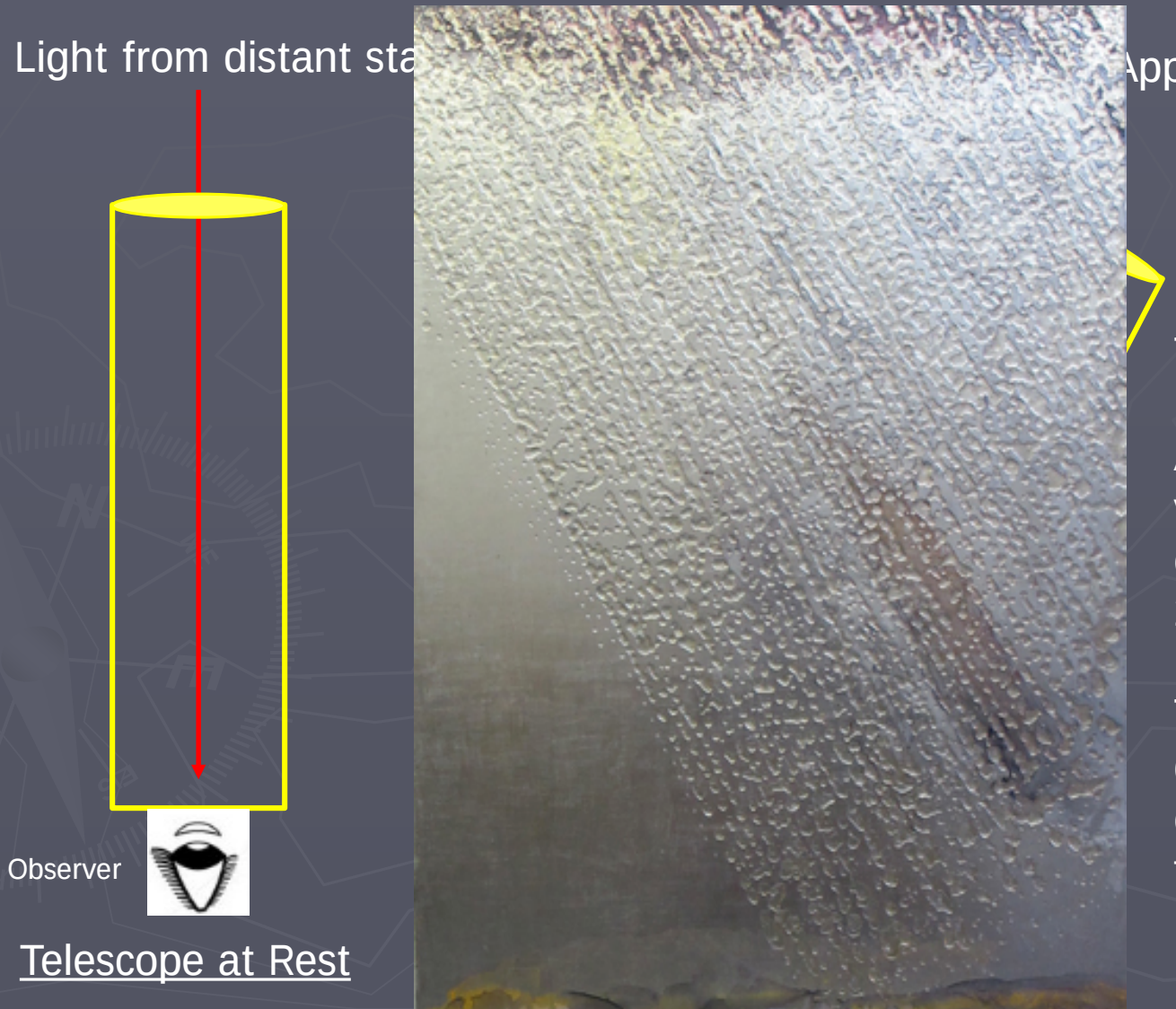
20

Stellar Aberration?

James Bradley (1693-1762)

- British astronomer James Bradley succeeded Halley as the Astronomer Royal in 1742.
- In 1725 he observed the star Gamma Draconis through his telescope over the course of a year. He was hoping to view a shift in the star's position due to stellar parallax caused by the Earth.
- After only two weeks the star had already shifted position - but by a much greater amount than he expected, and in the “wrong” direction for it to be parallax. Over a year it traced an ellipse in the sky.

Stellar Aberration



Telescope at Rest

Tan theta = v/c

At 30 km/s for earth velocity (v) and speed of light (c), this equals 20.5 arcseconds.

This was quite detectable in the 18th century with the technology of the day.

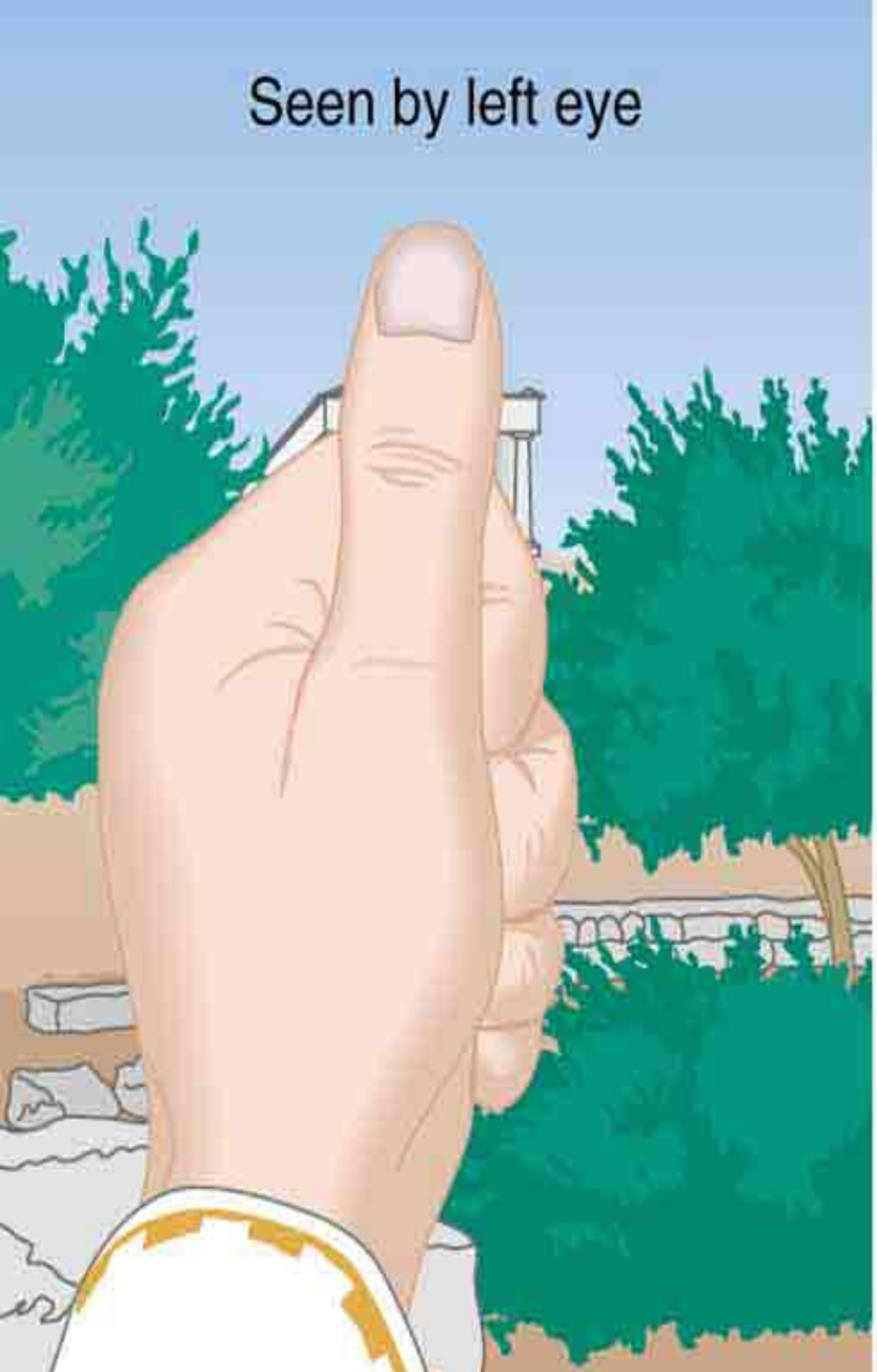
James Bradley (1693-1762)

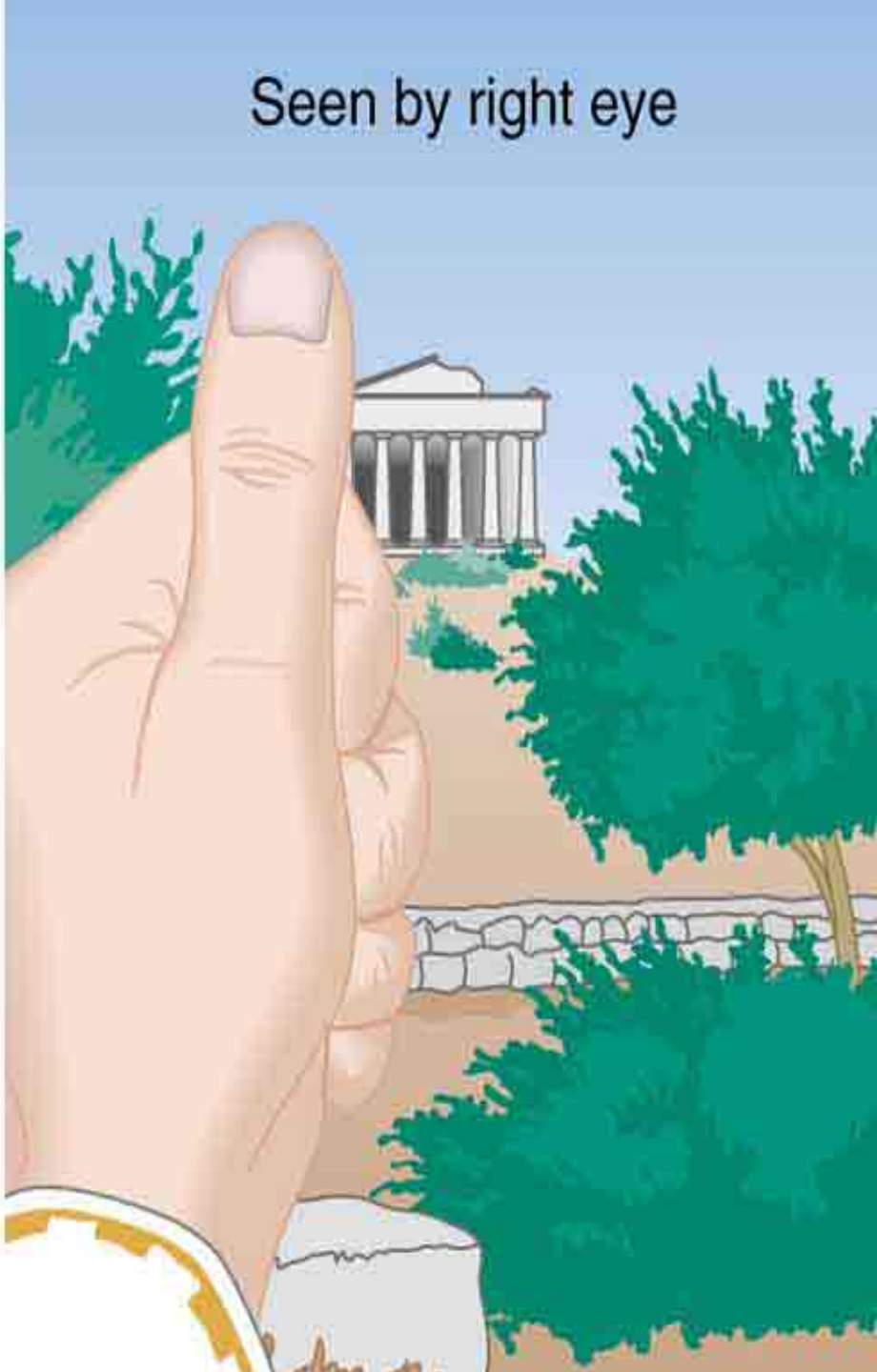
- The result puzzled him for a couple of years.
- While watching the wind vane on a sailing boat and observing that the wind vane pointed in a direction which was the resultant of the boat and wind directions combined.
- The motion of the earth around the sun was altering how we were seeing the stars.
- This surprise discovery, called stellar aberration, was proof that earth orbited the sun.

Stellar Parallax?

Stellar Distances

- The most reliable method for deriving distances to stars is based on the principle of Trigonometric Parallax.
- The parallax effect is the *apparent* motion of a nearby object compared to distant background objects because of a change in viewing angle.
- Put a finger in front of your nose and watch it move with respect to the back of the room as you look through one eye and then the other.


Seen by left eye

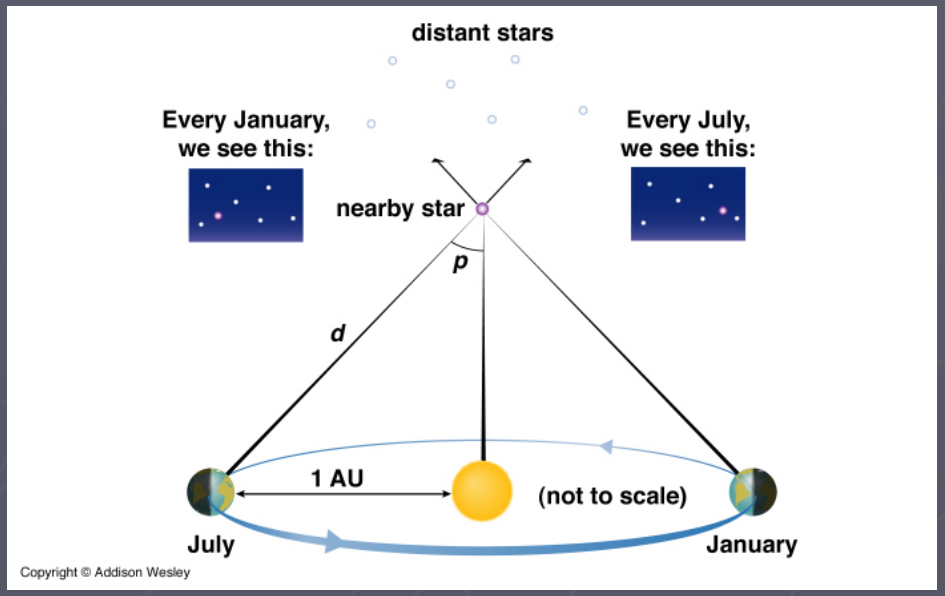

Seen by right eye

Stellar Distances

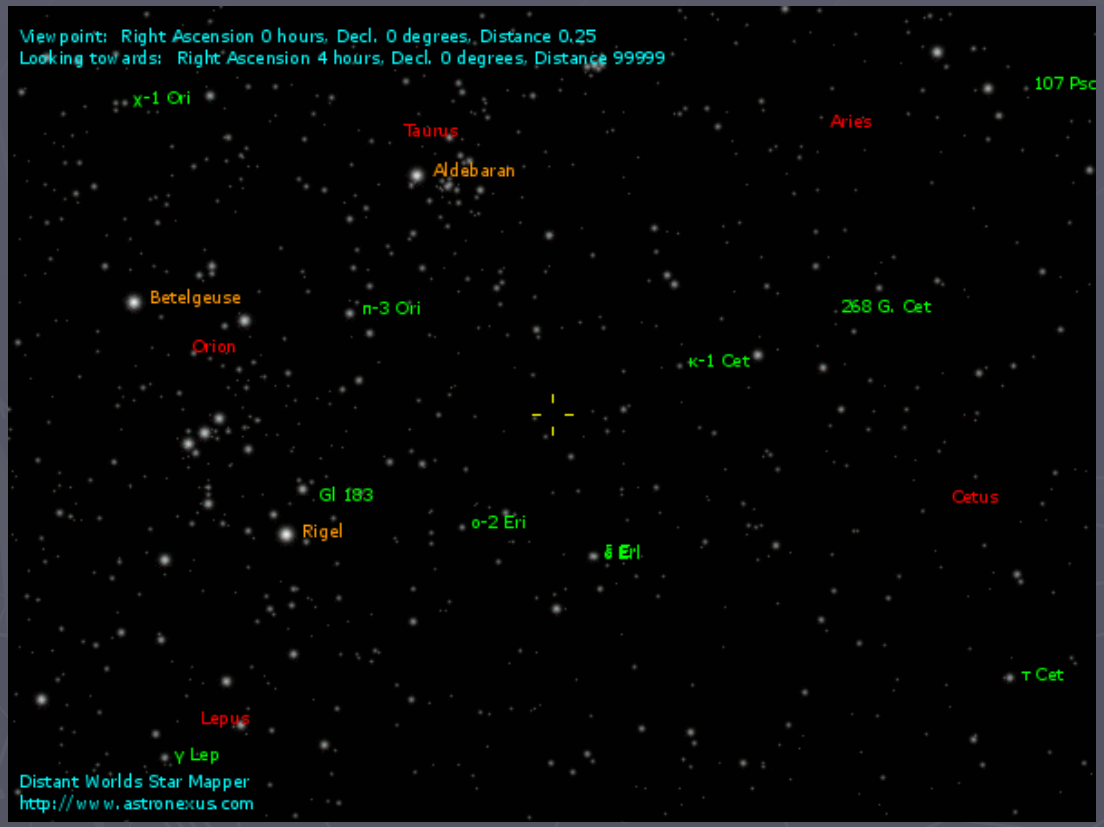
- For the experiment with your finger in front of your nose, the baseline for the parallax effect is the distance between your eyes.
- For measuring the parallax distance to stars, we use a baseline which is the *diameter of the Earth's orbit.*
- There is an apparent annual motion of the nearby stars in the sky that is really just a reflection of the Earth's motion around the Sun.

Friedrich Bessel (1784-1846)

- Many scientists tried to measure parallax but it wasn't until 1838 that it was accomplished by Friedrich Bessel.



- The width of the moon is about 0.5°. The separation that Bessel had to measure between the stars in the field of his telescope was only 0.00001742°, comparable to the width of a pizza in New York as observed from San Francisco!



What might stellar parallaxes look like if the Earth's orbit were 1.5 light-years (instead of 16 light-minutes) in diameter? The two closest stars in this region, Epsilon Eridani and Omicron^2 Eridani, are identified by name.

Source: AstronomyNexus.com

So what do we know now?

- Bessel calculated distance to 61 Cygni at 11.4 Light Years, he already knew that sunlight took 8 mins. to reach us, the idea of light taking 11.4 years was a profound shock. This was for a relatively close star!
- Parallax could now be measured, but it was very small, therefore many stars were extremely far away
- Ironically, Aristarchus' (200 BCE) heliocentric model had implied very remote stars. The distances were so unfathomable that he was ignored – he was right!

Immanuel Kant

Immanuel Kant (1724-1804)

- a German philosopher who is considered the central figure of modern philosophy.
- Proposed that the Milky Way was like a vast Solar System with stars prevented from collapsing inwards by orbiting in a plane.
- He speculated that from “outside”, the Milky Way would appear as a disc or an ellipse and that it would appear different from background stars.
- He was proposing what became known as “Island Universes”. His thinking was sound but had no mathematical support.

Source: Universal Natural History and Theory of the Heavens

Immanuel Kant (1724-1804)

- "Two things fill the mind with ever new and increasing admiration and awe, the more often and steadily we reflect upon them: the starry heavens above me and the moral law within me. I do not seek or conjecture either of them as if they were veiled obscurities or extravagances beyond the horizon of my vision; I see them before me and connect them immediately with the consciousness of my existence."

Source: Immanuel Kant, Critique of Practical Reason


BREAK!

An Extragalactic Universe?

The late 1700's, early 1800's

- There had been discussion of the idea of "Island Universes" during the 18th century (Kant, Wright, Laplace).
- Various catalogs existed with "objects" listed, but there was no understanding of what they were (Messier, de Caille, Herschel)
- Herschel had studied extended, faint areas of some of these objects, areas called "nebulae".
- Some argued these were clouds of gas within the Milky Way. Others thought they were massive star systems, so distant that their stars could not be resolved.

“The Great Debate” (1920)

How big is the Milky Way?

- Two leading US astronomers Harlow Shapley and Heber Curtis took part in a debate at the Smithsonian. Einstein was in the audience.
- Shapley's measurements had revealed that globular clusters were much farther away (10x) than expected and that the sun was far from the centre.
- Curtis studied spiral nebula and concluded they lay beyond the relatively small radius of the Milky Way.
- Both were partly right. Shapley knocked the sun from the centre, Curtis showed that the Milky Way wasn't unique or special.

Albert Einstein

Albert Einstein (1879 – 1955)

- Albert Einstein was a German-born theoretical physicist & philosopher of science. He developed his Theories of Relativity, pillars of modern physics.
- Although he was a clever child building mechanical devices for fun, he was also considered a slow learner. It's possible he was dyslexic.
- Received the Nobel Prize in 1921 for his 1905 work on the photoelectric effect.
- Received the Copley Medal of the Royal Society in 1925 and the Gold Medal of the Royal Astronomical Society in 1926.

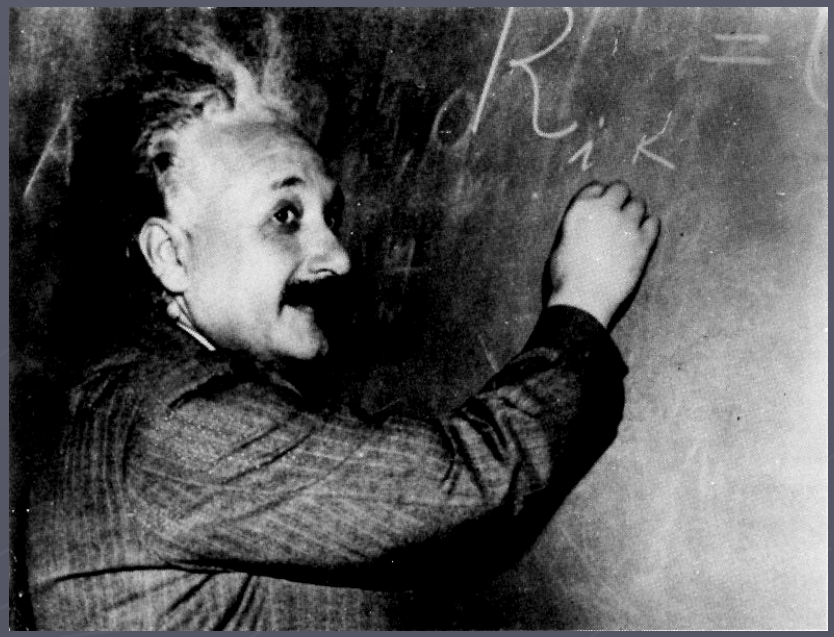
Albert Einstein (1879 – 1955)

- Einstein's primary contribution to Astronomy was to show how mass and energy were equivalent.
- In 1905 his Special Theory of Relativity adjusted Newtonian Dynamics by making a connection between space and time. A decade later his General Theory showed how gravitation could be explained in terms of the curvature of space.
- The Special Theory of Relativity was developed for a Universe consisting of only one galaxy with the sun at the centre! The galaxy was a static one.

Albert Einstein (1879 – 1955)

- In 1952, after the death of Chaim Weizman he was offered the position of President of the new state of Israel.

  He declined the offer.

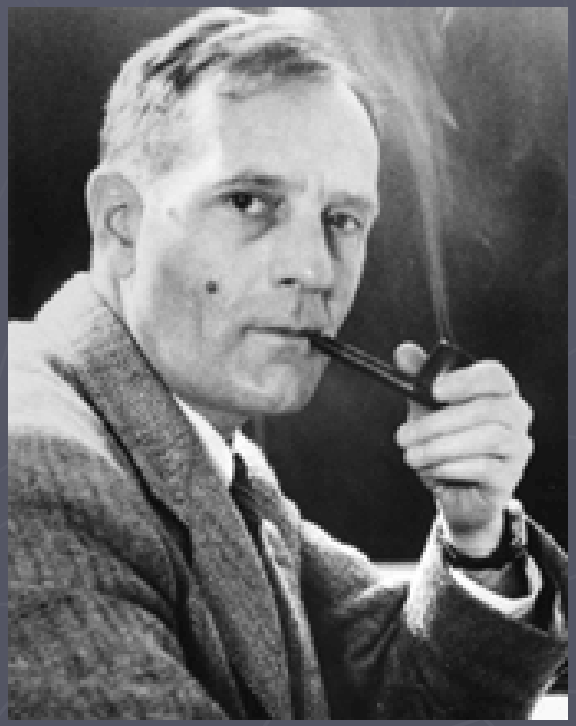


- One week before his death he sent his last letter to Bertrand Russell in which he agreed that his name should go on a manifesto urging all nations to give up nuclear weapons.

Edwin Hubble

Edwin Hubble (1889–1953), American

- Hubble’s major contribution to astronomy and cosmology was his discovery that faraway galaxies are moving away from us.
- Known as Hubble's Law, the theory states that galaxies recede from each other at a rate proportional to their distance from each other.
- This concept is a cornerstone of the Big Bang model of the universe.



Edwin Hubble

- He also answered one of the major remaining astronomical questions of his day – how big is the universe?
- Prior to Hubble, the conventional view of astronomers had been that the Milky Way was the universe.
- He showed that the Andromeda galaxy lay far beyond the Milky Way and was receding from us.
- This was just as big a paradigm shift as the realisation that the Earth travelled around the Sun was in its day.

Edwin Hubble

- When Hubble started his research it was widely held that the Milky Way contained “everything” in the universe.

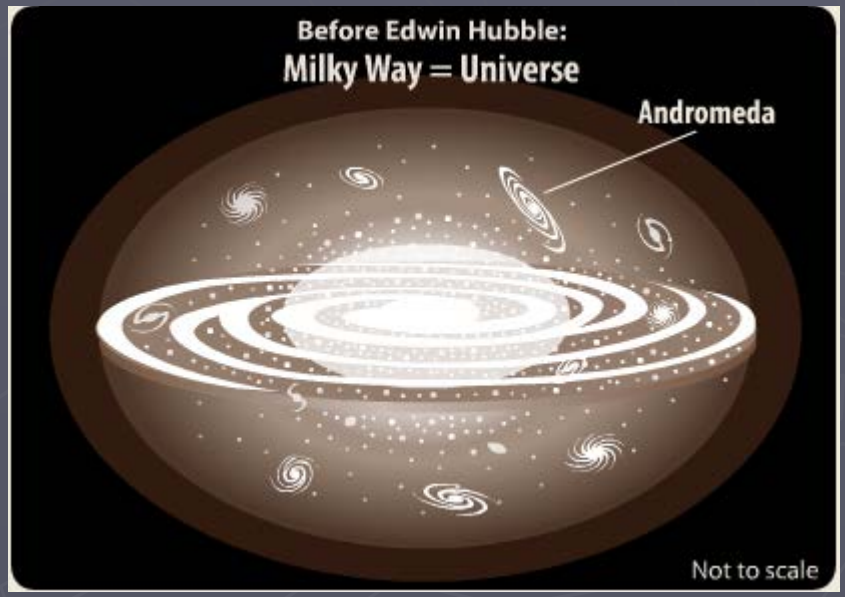
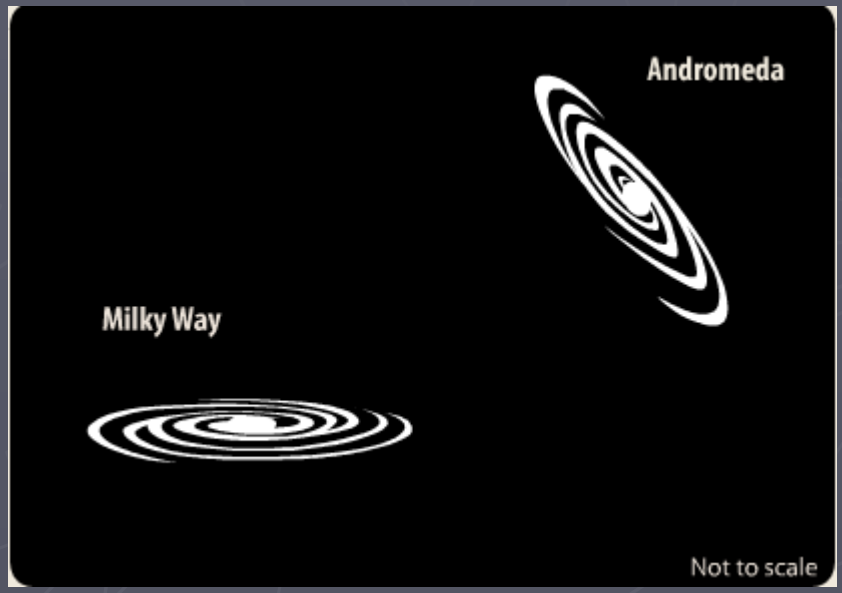


Image: amazing-space.stsci.edu

Edwin Hubble

- The revelation of the size of Andromeda and it's distance from us was truly startling.
- Andromeda was an object of similar size to our Milky Way but a great distance away.



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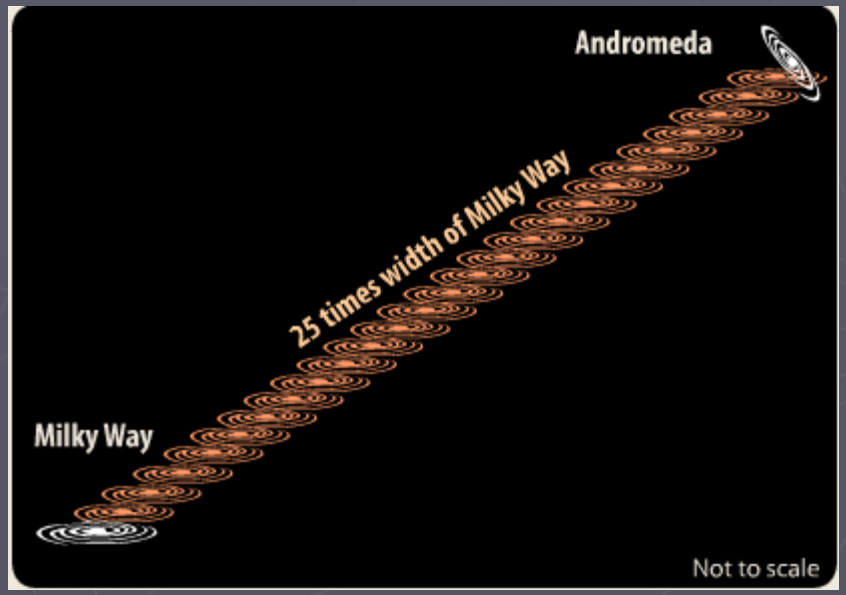
Edwin Hubble



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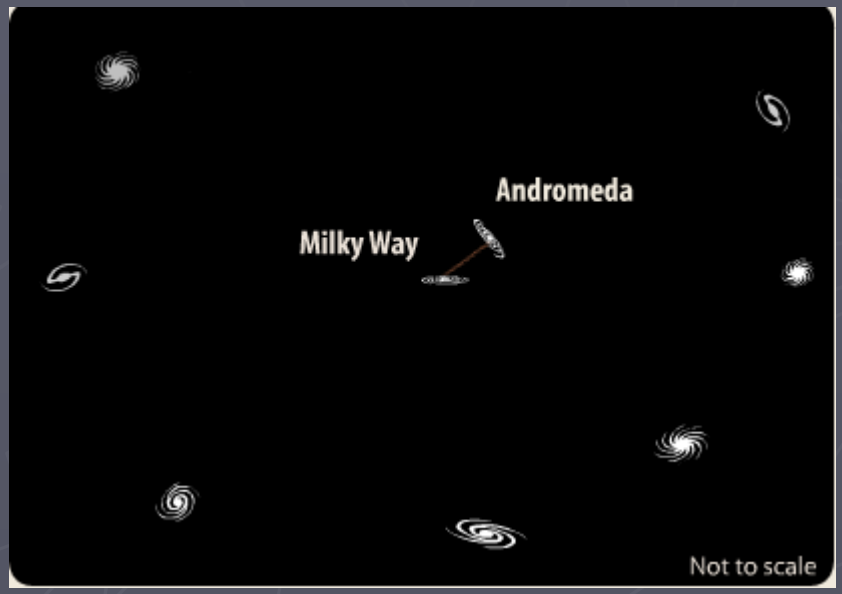
Edwin Hubble

- Most galaxies are much further away even than Andromeda.
- Milky Way is just a small part of a huge Universe.
- The Universe is expanding.
- Our Sun is just one of countless stars.
- How humbling!



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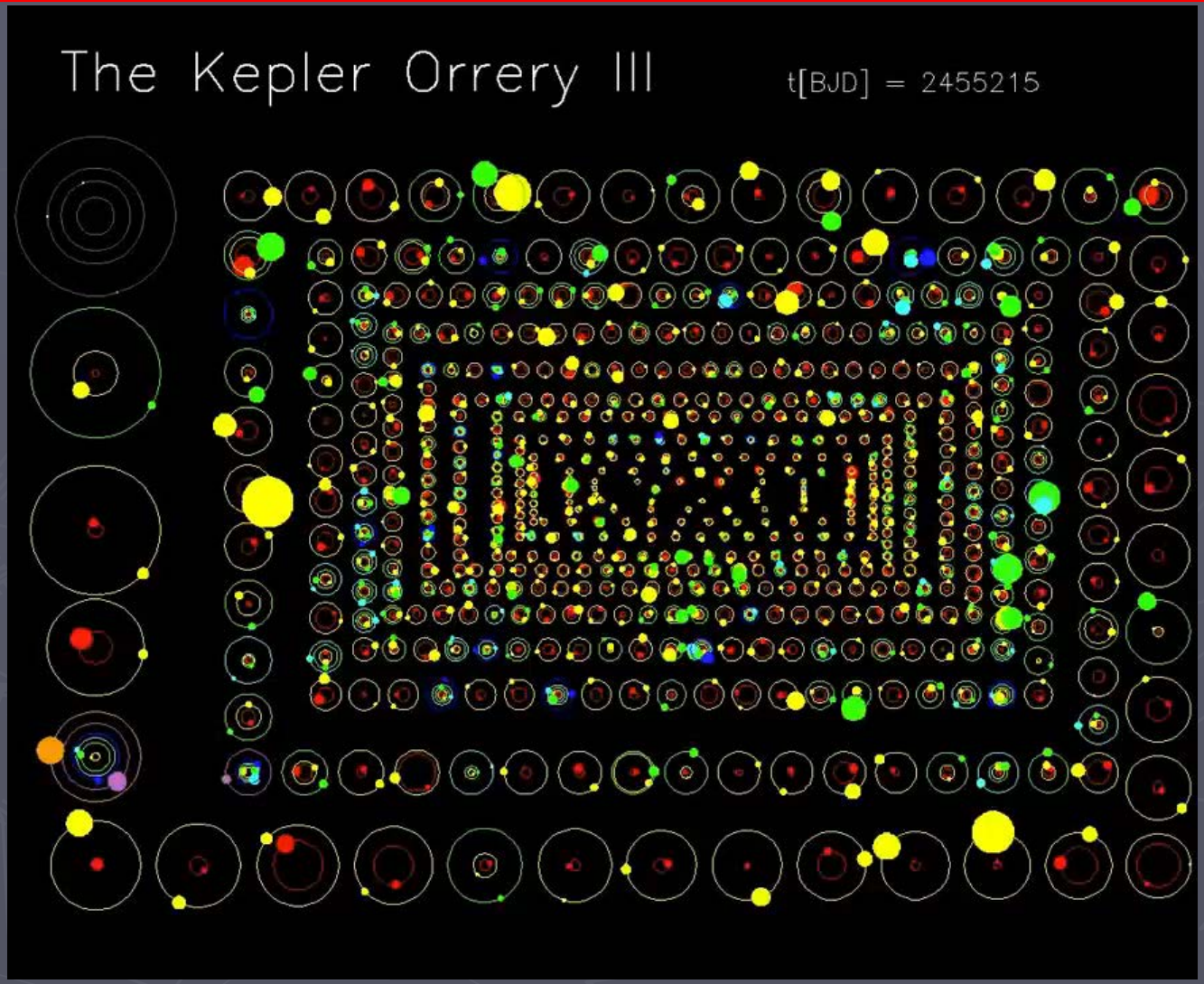
Orrery of Solar System – ca 500 BCE

Kepler Project – Orrery 2015



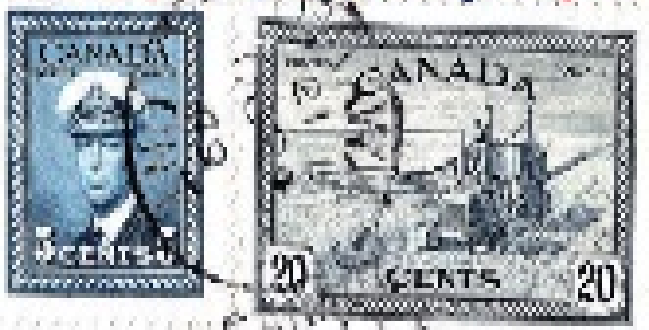
The Universe is Very Big!

Space is big. You just won't believe how vastly, hugely, mind- bogglingly big it is.

I mean, you may think it's a long way down the road to the chemist's, but that's just peanuts to space.

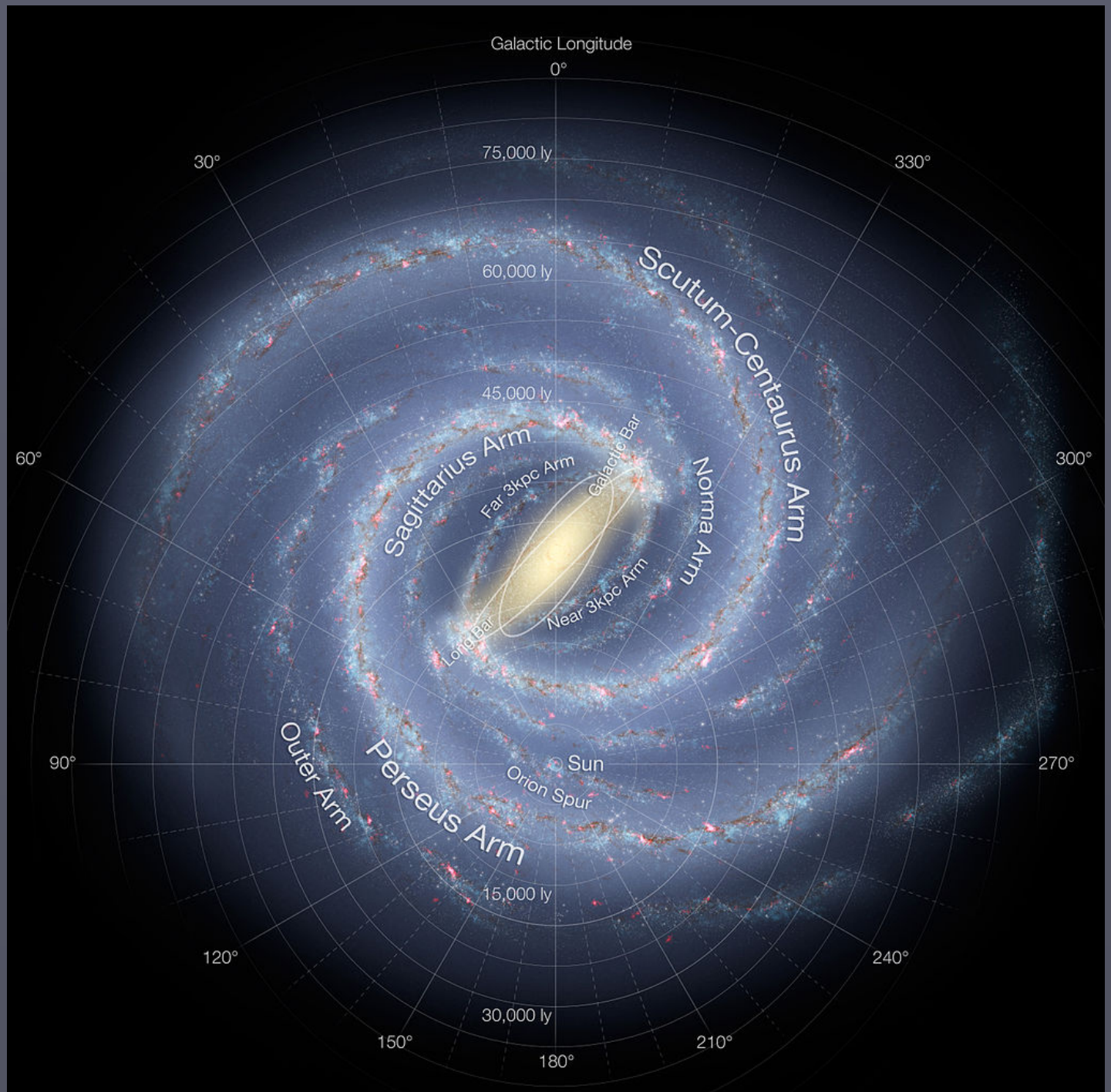
Douglas Adams,

The Hitchhiker's Guide to the Galaxy. (1952 - 2001)



Planet No. 3,
Solar System,
Orion Spur on Sagittarius Spiral Arm,
Milky Way,
Local Cluster,
Virgo Supercluster,
Universe,
Multiverse.

PAR AVION VIA AIR MAIL CORREO AEREO


Galactic Longitude
0°
30°
330°
60°
300°
90°
270°
120°
240°
150°
210°
180°
75,000 ly
60,000 ly
45,000 ly
30,000 ly
15,000 ly
Scutum-Centaurus Arm
Sagittarius Arm
Norma Arm
Perseus Arm
Outer Arm
Far 3kpc Arm
Near 3kpc Arm
Galactic Bar
Long Bar
Sun
Orion Spur

Cosmology today?

- The history of astronomy has been a journey that moved us farther and farther from the centre.
- It's a principle of irrelevance that involves not only our position in space and time but also the very “stuff” the universe is made of.
- We now know that a hidden ocean of cosmic matter -- comprising about 85 percent of the universe's mass -- surrounds us.
- And, our universe may not be the only one!

Cosmology today?

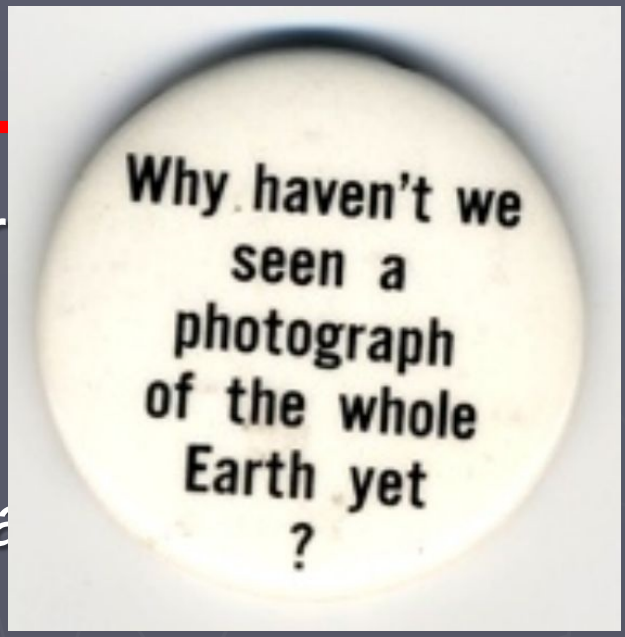
- Astronomer Harlow Shapley always explained how each step in shifting the “centre” was a retreat from “anthropocentrism”.
- To him, anthropocentrism was reflected in pre-scientific cosmologies, superstitions and the approaches taken by most religions.
- Anthropocentric thinking was an obstacle to true understanding of the cosmos, so he argued that its decline marked the triumph of rationality and should be celebrated.

Source: Cosmos and Culture, NASA History Series, 2009

Cosmology today?

- In 1953 the poet Edith Sitwell was visiting Edwin Hubble's home in California:
- *… he showed me slides of universes unseen by the naked eye, and millions of light-years away. I said to him 'How terrifying!' 'Only when you are not used to them,' he replied. 'When you are used to them, they are comforting. For then you know that there is nothing to worry about - nothing at all!'*

Cosmology today?



- In 1948, the British astronomer Fr
  predicted that:

  "once a photograph of the Earth,
  outside, is available...a new idea a
  in history will be let loose."

- In 1966, a visionary college student in the US, Stewart Brand, created and sold these buttons:

- In the fall of '68, Stewart Brand would publish such an image on the cover of his influential *Whole Earth Catalog.*

The image that "*saved 1968*"

1968

Tet offensive

Assasination of Martin Luther King

Assasination of Robert Kennedy

Black Power at Mexico Olympics

Riots at Democratic Convention

Student riots in Paris

...

“Earthrise”

- The crew of Apollo 8 had successfully captured an image that would alter human consciousness:
  - The radiant, living Earth
  - Resplendent in space
  - Juxtaposed against the barren lunar landscape and the dark expanse of space
  - Floating; infinitely beautiful
  - Sunlit against the black cosmos
  - Wet with oceans and alive with swirling clouds
- The iconic "Earthrise" picture would later be called "*the single most influential environmental photograph ever taken*."

Source: The photograph that changed the world, Drew Dellinger

“Earthrise”

- Later that same evening, the crew did a live Christmas Eve television broadcast, and up to a billion people around the world tuned in and saw the Earth as they never had before.
- Days later, when the Apollo 8 capsule splashed down, television reporter David Brinkley said, "the human race, without many victories lately, had one today."
- After the mission, Commander Frank Borman received a telegraph from a stranger that simply read, "Thank you Apollo 8. You saved 1968."

The 70’s, “What’s Going On"

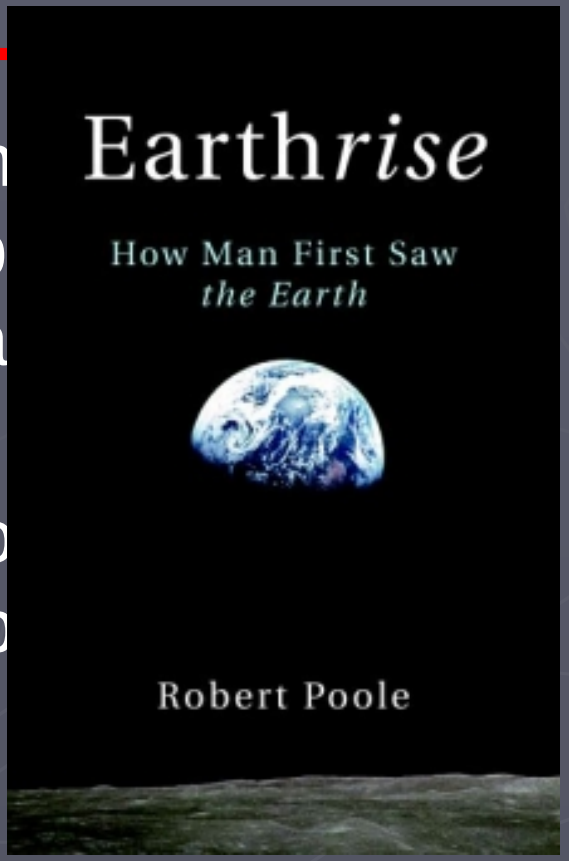
- As Fred Hoyle had predicted, a powerful new idea was unleashed: a new era of ecology and environmental consciousness was born.
- In 1970, the nascent “Earth Day" erupted into a national event in many countries.
- Joni Mitchell's song “Big Yellow Taxi" hit the airwaves with its cautionary tale of trees in a museum, birds and bees decimated by DDT, and foolish humans who 'don't know what they've got 'til it's gone.'

The 70's, "What's Going On"

- 1971, M t's Going C (The *Ecology*
- In 1972 n the environ Club of Rom *The Limits t*
- In 1973 in Endang (CITES) was signed.
- Clearly, something was going on.

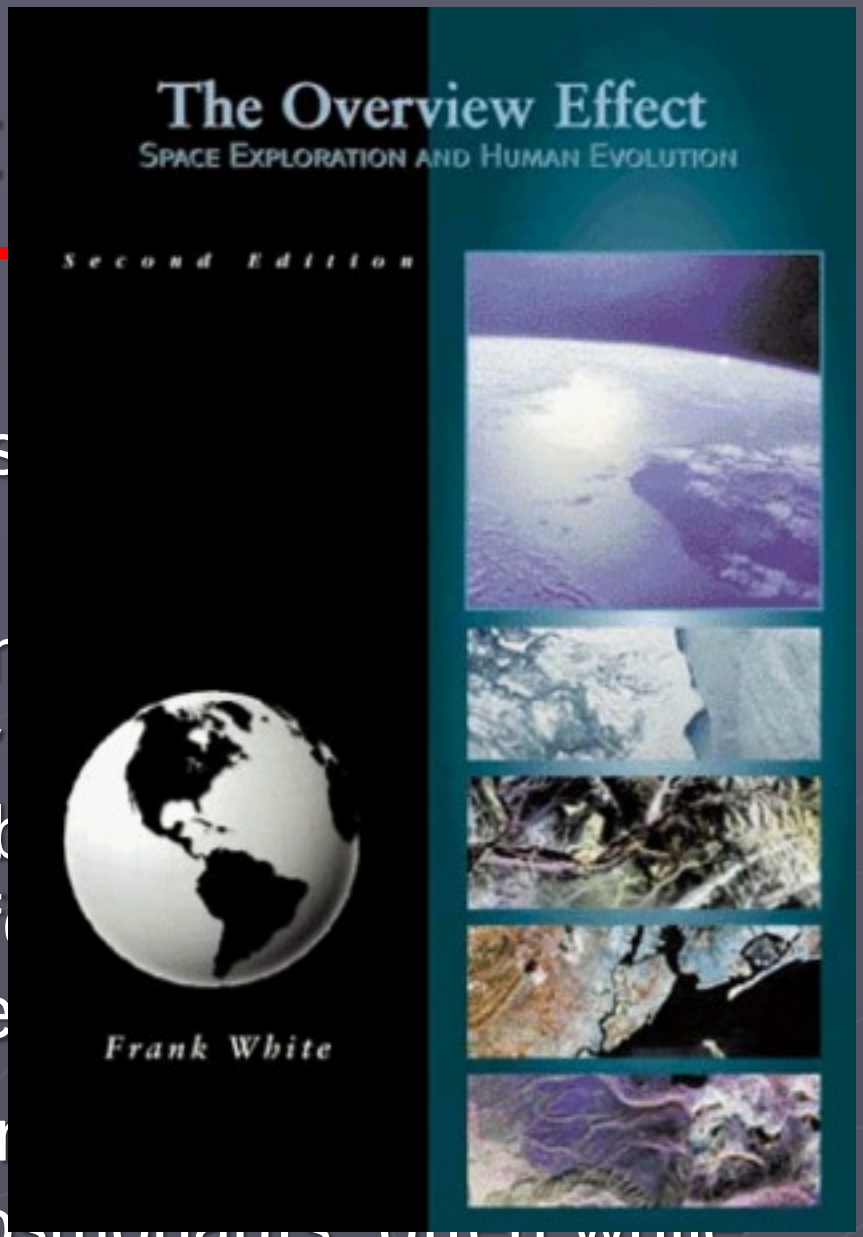
The unintended consequence

- The greatest unintended consequen
space age was that our push to exp
and beyond turned our attention ba
circumstances here on Earth.
- We were startled by a perspective o
that shifted our understanding of sp
exploration "from what it meant for
it meant for the Earth".
- This led directly to the blossoming of an environmental movement that became global in scope.



The Overview Effect

The Overview Effect



- The Overview Effect is the emotional, and spiritual res Earth from space.
- The term was used by Frar book *The Overview Effect: Human Evolution* to describ astronauts describing the f they had when viewing the
- The term refers to a shift i by some astronauts and co viewing Earth from orbit or from the moon.

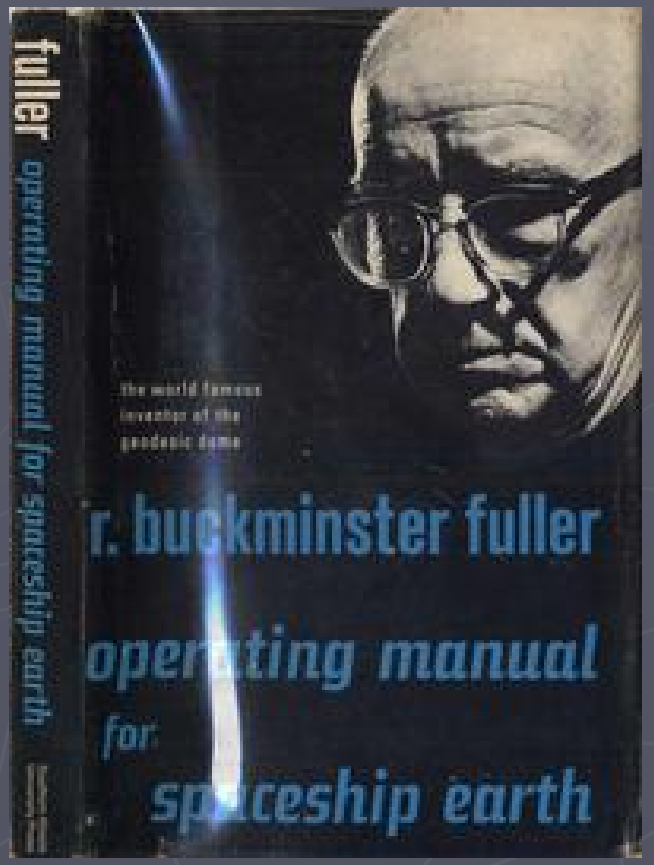
The Dymaxion Earth (Buckminster Fuller)

This version depicts the Earth's continents as "one island," or nearly contiguous land masses.

The land masses are projected onto an icosahedron.

Spaceship Earth (1968)

- The book relates Earth to a spaceship flying through space.
- The spaceship has a finite amount of resources and cannot be resupplied.
- Likens humanity to a chick that has just broken out of its shell and is now ready to enter the next phase of its existence.
- Asks "How big can we think?"



Source: Wikipedia

Does the Universe actually have a centre?

Does the Universe actually have a centre?

- Todays standard theory in cosmology is that the Universe started with a “Big Bang”.
- This was not an explosion “in space”, it was an explosion “of space”.
- Before the Big Bang there was no space or time. There wasn’t even a “before”.
- The Big Bang is very different from any explosion we have experienced, it does not actually have a central point of origin!

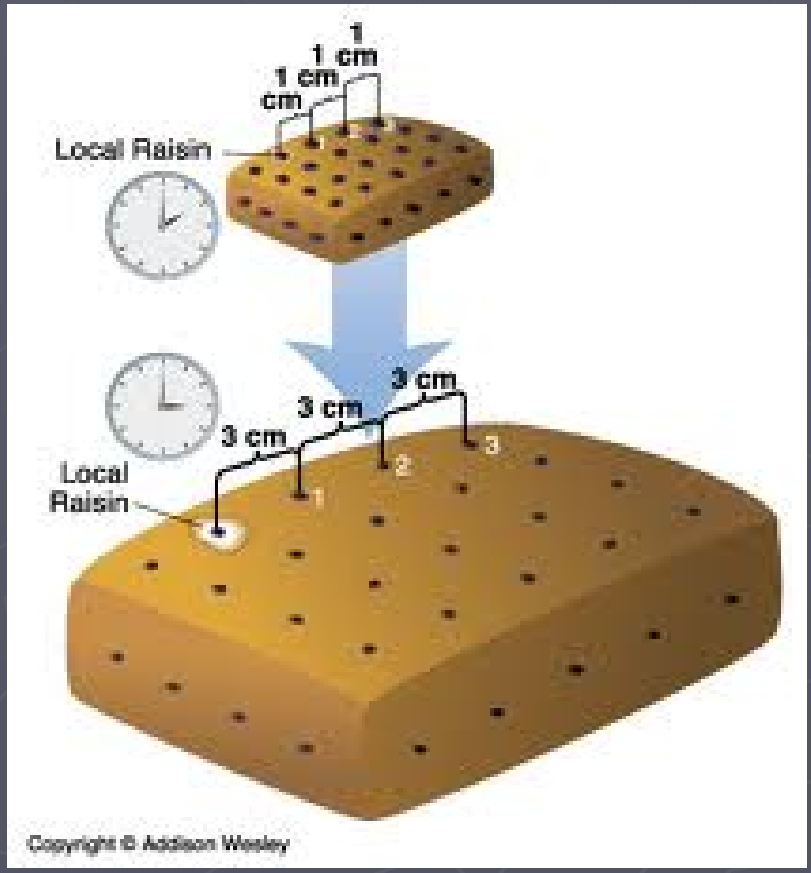
Does the Universe actually have a centre?

- If it were an ordinary explosion we'd be able to see the edge moving outwards.
- Instead we see the Cosmic Microwave Background Radiation, the glow from the early universe, and it is uniform in all directions.
- All measurements made so far indicate that the Universe is homogeneous at the larger scales (galaxies etc), indicating that there is no central dense point.

How the Universe Expands

- The space between galaxies expands, not the galaxies themselves; objects held together by their own gravity are always contained within a patch of non-expanding space.

- Example: raisins in a loaf of bread.
  - As the dough rises, the overall loaf of bread expands; the space between raisins increases but the raisins themselves do not expand.



Closing thoughts from Harlow Shapley

- While getting past anthropocentrism and the barrier of human ego was difficult, Shapley had suggested the payoff would be worth it.

- Vanity as a consequence of place was supplanted by a humility that encouraged a new perspective on humanity within the cosmic scheme.

- As he suggested in one of his many radio talks:

We do not amount to much in size, or in duration either for that matter; but we have the gift, I hope, of humility and reverence and we have an inborn impulse to learn and understand.

We may, therefore, not be inconsequential in this scheme of stars, of gravitation, and of empty space. At any rate, we are composed of star-stuff and we are a part of a magnificent universe

Source: Harlow Shapley

- Next time you hear a scientist saying something like "the more we know about the universe the less important we become," beg to differ.

- The reality is precisely the opposite: The more we know about the universe, the more unique we become.

- What we do with this knowledge is, of course, a personal choice for each of us. To have this choice is the privilege of being human.

Source: Marcelo Gleiser, Dartmouth College


Thank You!

Additional Credits

- Some material included in this presentation was taken from online sources. Particular credit to:
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  - Andrew Liddle, Univ. Sussex
  - RASC Canada, http://www.rasc.ca
  - *ftp://ftp.astronomy.ohio-state.edu/pub/jaj/a1143/sp14lect6.ppt*
  - Syney Harris Cartoons, http://www.sciencecartoonsplus.com/index.php
  - BC Knowledge Network, https://www.knowledge.ca/program/space-suite
  - Cosmos and Culture, NASA History Series, 2009, *www.npr.org/sections/13.7/*
  - Celestial Sleuth, Donald Olson*./ISBN 978-1-4614-8402-8, Springer*