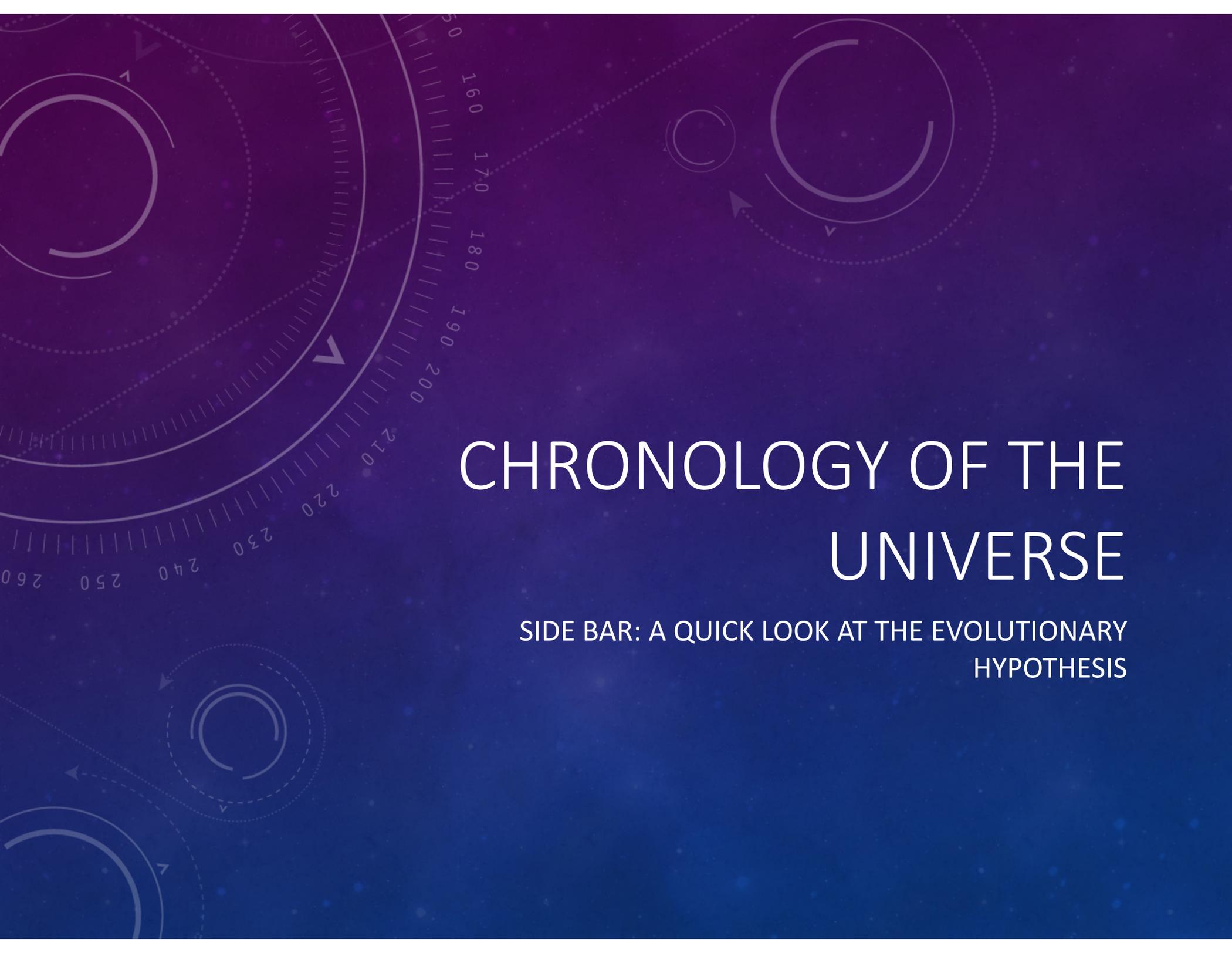


# CHRONOLOGY OF THE UNIVERSE

FROM THE CREATION OF THE SOLAR SYSTEM TO THE  
PRESENT DAY

The background features a dark blue gradient with faint, glowing circular patterns and a scale. The scale is a large arc on the left side, with numbers ranging from 160 to 260 in increments of 10. There are also several smaller circular diagrams with arrows, suggesting a cycle or process. The overall aesthetic is scientific and futuristic.

# CHRONOLOGY OF THE UNIVERSE

SIDE BAR: A QUICK LOOK AT THE EVOLUTIONARY  
HYPOTHESIS

## 5 DEFINITIONS FOR EVOLUTION

**Macro-Evolution** or Darwinian evolution – descent from a common ancestor with modification by completely mechanistic, naturalistic means... (undirected and unguided)

originally articulated by Charles Darwin in 1859 when he originally published his “origin of the species”

Causes of skepticism for Darwinian Evolution -

- Multi-regionalism – human origins arise in many locations around the world at once (out of Africa model is currently widely held as more accurate) human origins from single location
- Evidence shows All humanity can be genetically traced back to a mitochondrial Eve and Y chromosome Adam



## 5 DEFINITIONS FOR EVOLUTION

**Macro-Evolution** or Darwinian evolution – descent from a common ancestor with modification by completely mechanistic, naturalistic means... (undirected and unguided)

- Evidence shows All humanity can be genetically traced back to a mitochondrial Eve and Y chromosome Adam
- Transitional forms of hominids in the archeological record do not appear to exist – no known mechanism to allow a quadrupeds to morph into a biped
- Neanderthals should be related to humans and have been shown genetically to be a distinct species
- No explanation for the Cambrian explosion nor the rapid appearance of completely new creatures after all the extinction events
- Predicts "junk DNA" in the genomes of species
- Requires unguided and undirected abiogenesis (chemical evolution)



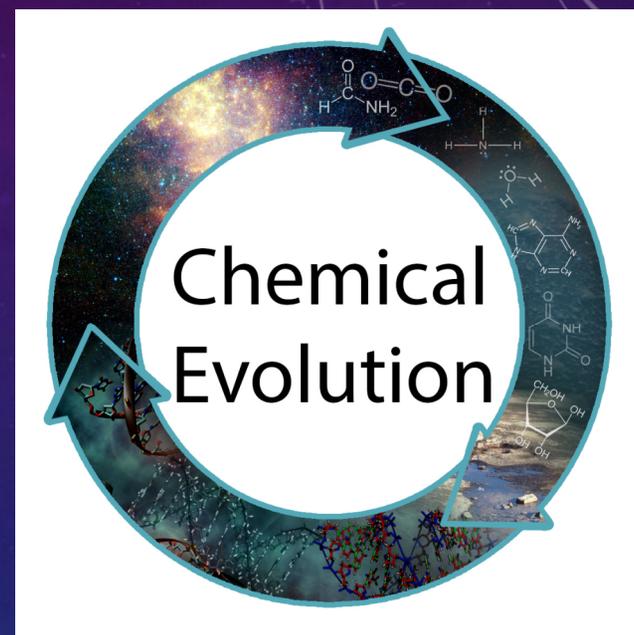
# CHRONOLOGICAL VS MORPHOLOGICAL PHYLOGENY

- **Phylogeny** is the study of relationships among different groups of organisms and their evolutionary development. Phylogeny attempts to trace the evolutionary history of all life on the planet (source: <https://www.britannica.com/science/phylogeny>).
- **Morphology** is the study of the size, shape, and structure of animals, plants, and microorganisms and of the relationships of their constituent parts. The term refers to the general aspects of biological form and arrangement of the parts of a plant or an animal (source: <https://www.britannica.com/science/morphology-biology>).
- Archaeopteryx (ah-kee-op-tuh-riks) is (was) considered a transitional form from dinosaurs to modern birds. It has feathers & was believed could fly. The fossil is dated to about 150-148 MYA.
- Xiaotingia zhengi (zhow-tin-gee-ah zen-gi) is an example of a feathered bird found some 5 MY earlier in the fossil record.



## 5 DEFINITIONS FOR EVOLUTION (CONT)

- **Chemical Evolution** - small molecules within the model inventory of prebiotic chemistry can self-assemble into polymers that resemble RNA and proteins ([www.centerforchemicalevolution.com](http://www.centerforchemicalevolution.com)) and ultimately DNA
  - Self-directed assembly appears as evidence for directed assembly. Complex assembly of Polymers in the lab only occur at the direction of a mind(s) (the researchers)
- Distinct lack of evidence for this type of evolution in the fossil record
- No evidence has been found in the fossil record of a “primordial soup”
- UV/O<sub>2</sub> paradox is still a problem for the assembly of a very delicate nucleic acids like DNA and RNA; no explanation



[Dr. James Tour](#)

[James Tour Group - Rice University](#)

## 5 DEFINITIONS FOR EVOLUTION

- **Micro – Evolution** or Adaptation – ability of an organism to adapt to new pressures and conditions within its environment. These would include new sources of food, climate / habitat changes and changes occurring as a result of predation.
- **Speciation** – is a process by which a species diverges into new genetically diverse species to the point where they can no longer mate and produce fertile offspring.
  - Examples include finches on the Galapagos islands (5 species), felines, canines, and equidae.
- Sometimes an organisms ability to adapt to a new environment really backfires....



## 5 DEFINITIONS FOR EVOLUTION (CONT)

- **Microbiological Evolution** – The adaptation of microbiological organisms.
- These organisms can adapt to new environments very quickly as evidenced by bacteria developing resistance to new antibiotics
- Michigan State University Long Term Evolution Experiment has been running since 1988, under the direction of Dr. Richard Lenski  
<http://myxo.css.msu.edu/ecoli/> studying e coli generations. Near the 90,000 generation... interesting results
  - Follow on generations of e-coli have become larger and adapted to new sources of food and environmental conditions... but they are still e-coli....



## 5 DEFINITIONS FOR EVOLUTION – THE EVIDENCE

- The evidence in nature supports the concepts of micro evolution, speciation and microbiological “evolution” as these are species **adapting** to their environments...
- A better explanation of this evidence however would be a **Designer who is good enough to build an adaptation features** to help insure survival of that species
- **The evidence from nature does not support chemical evolution or macro evolution.** It is quite probable that Darwin (and Neo-Darwinists today) observed adaptation taking place and extrapolated (inferred / assumed) macro evolution.
- With the assumption of macro evolution, then chemical evolution must also be assumed to explain the first organism from which all other organisms have “descended with modification”
- What about intelligent design or ID?

## A BRIEF ON INTELLIGENT DESIGN

Intelligent Design (ID): Intelligent design refers to a scientific research program as well as a community of scientists, philosophers and other scholars who seek evidence of design in nature. The theory of intelligent design holds that certain features of the universe and of living things are best explained by an intelligent cause, not an undirected process such as natural selection (source: <https://biologos.org/series/science-and-the-bible/articles/intelligent-design-history-and-beliefs>)

Secular progressives like the ACLU define ID like this:

**Q: What is intelligent design?**

A: Intelligent design (ID) is a pseudoscientific set of beliefs based on the notion that life on earth is so complex that it cannot be explained by the scientific theory of evolution and therefore must have been designed by a supernatural entity (source: <https://www.aclu.org/other/frequently-asked-questions-about-intelligent-design>).

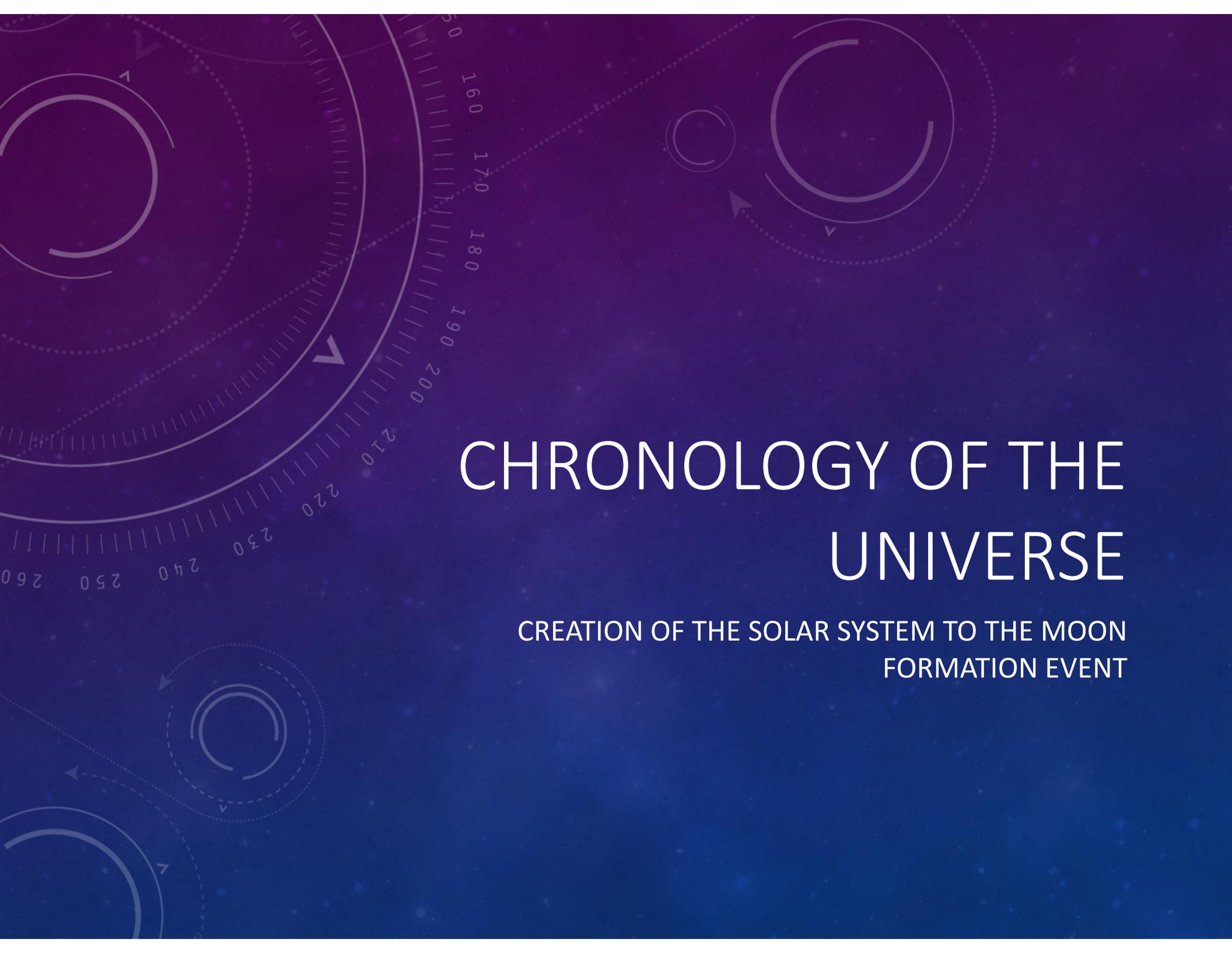
Antagonists and critics resist ID for the same reasons BB Cosmology was resisted by the scientific community in the 20<sup>th</sup> century.... It opens the door for the God of the Bible, which our adversary fights against with all his might... In the time we have left, you can decide for yourselves...

The background is a dark blue gradient with a starry texture. On the left side, there is a large, semi-circular scale with tick marks and numbers ranging from 160 to 260. Several circular patterns, some solid and some dashed, are scattered across the image, some with arrows indicating direction.

# CHRISTIAN APOLOGETICS

END OF SECTION

(A QUICK LOOK AT THE EVOLUTIONARY HYPOTHESIS)



# CHRONOLOGY OF THE UNIVERSE

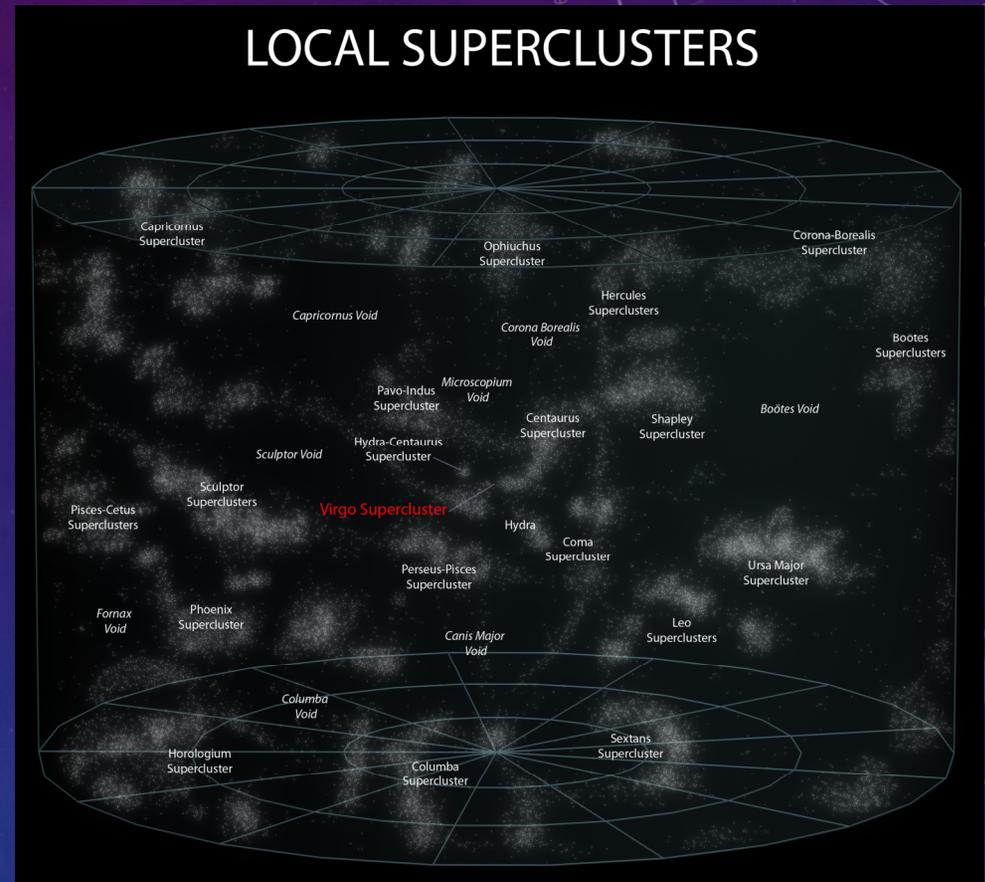
CREATION OF THE SOLAR SYSTEM TO THE MOON  
FORMATION EVENT

# Location of earth in the universe

## OBSERVABLE UNIVERSE



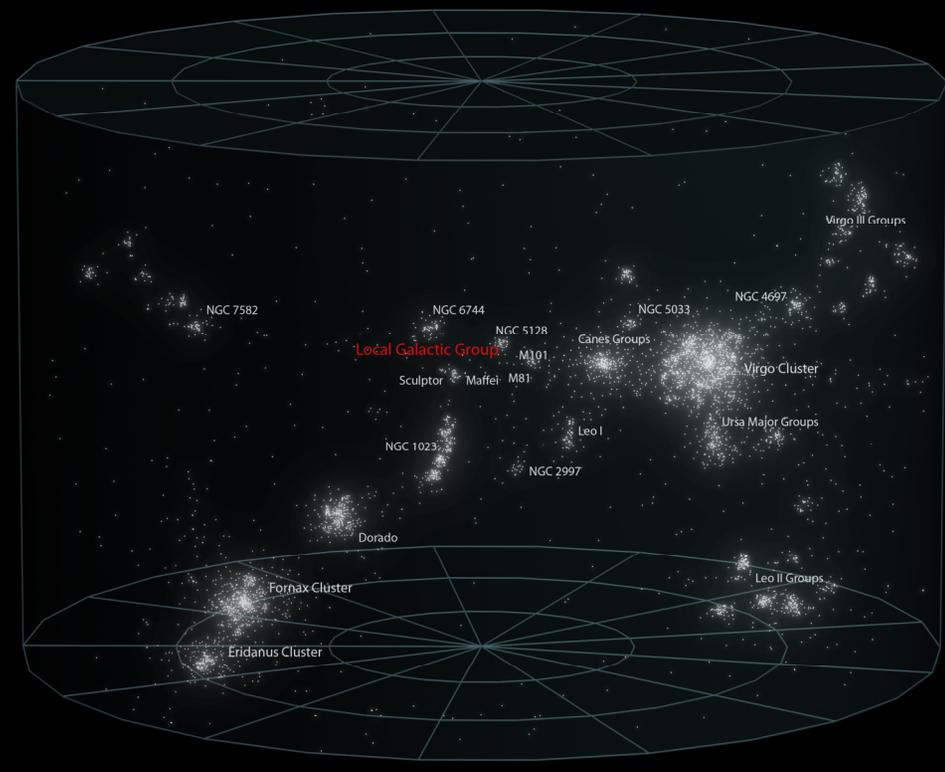
## LOCAL SUPERCLUSTERS



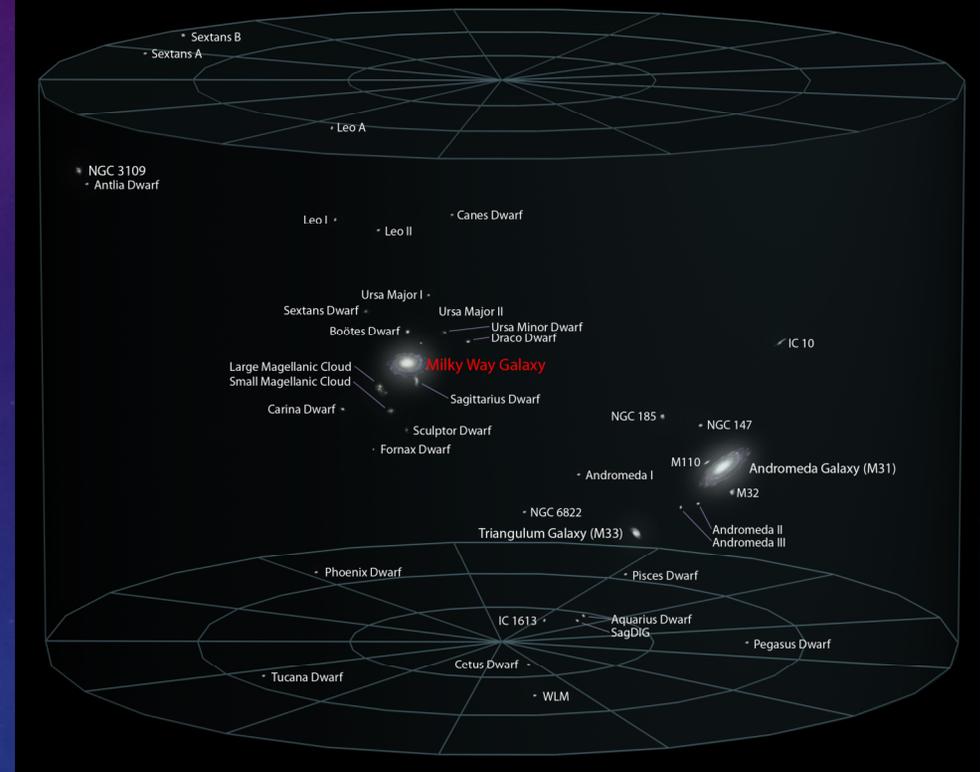
- By Andrew Z. Colvin - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=14358437>

# Location of earth in the universe

## VIRGO SUPERCLUSTER



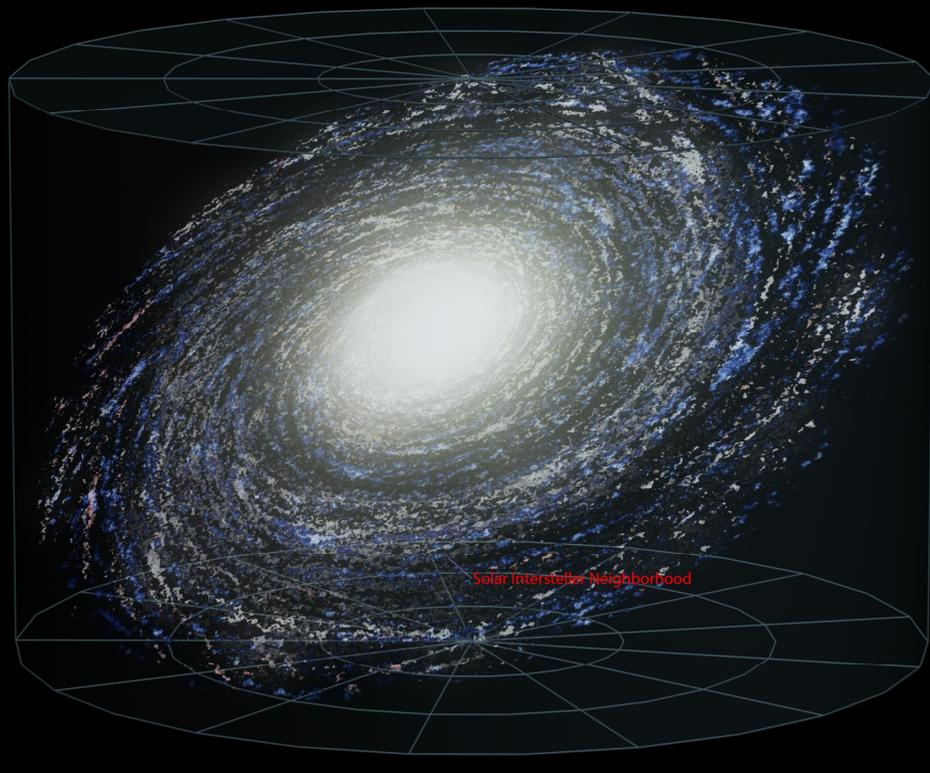
## LOCAL GALACTIC GROUP



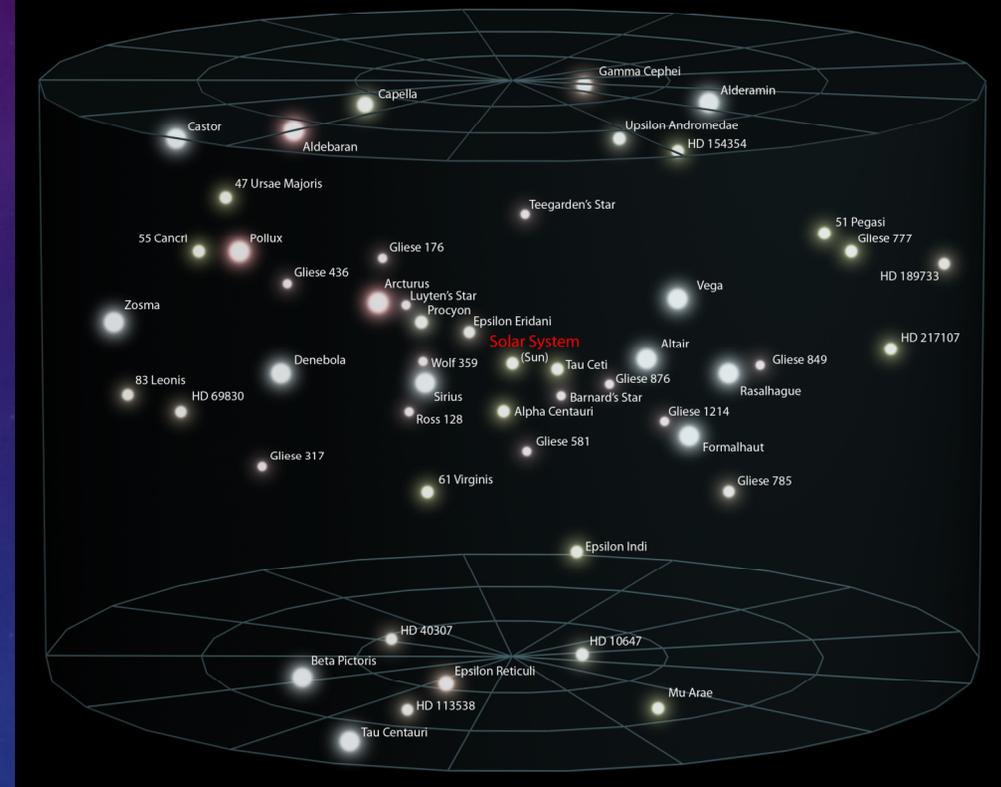
- By Andrew Z. Colvin - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=14358437>

# Location of earth in the universe

## MILKY WAY GALAXY



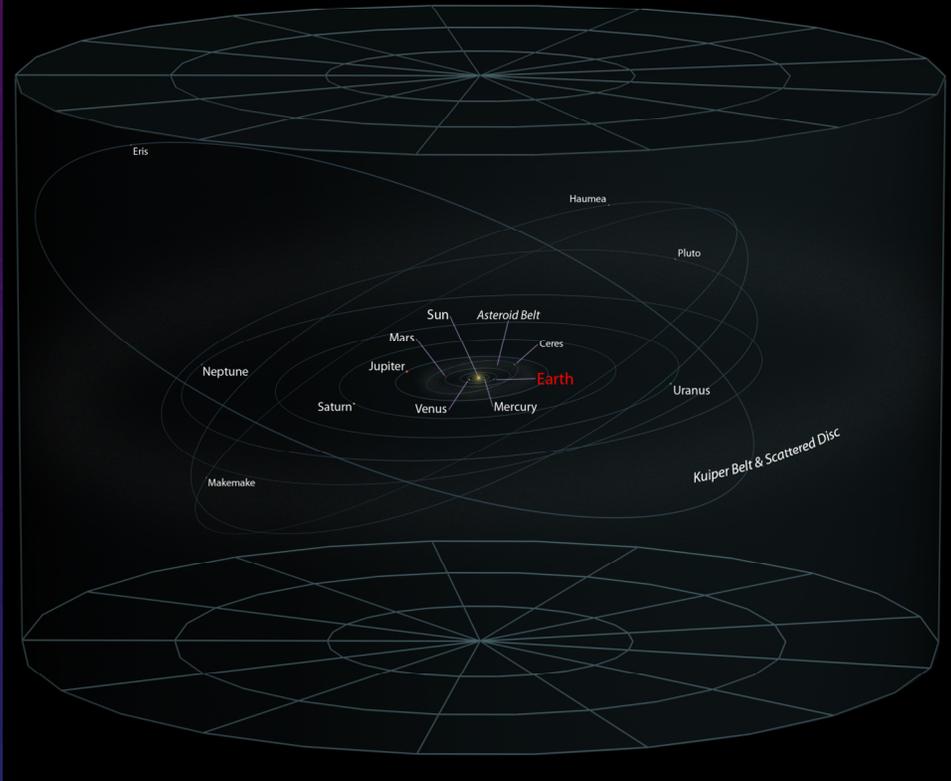
## INTERSTELLAR NEIGHBORHOOD



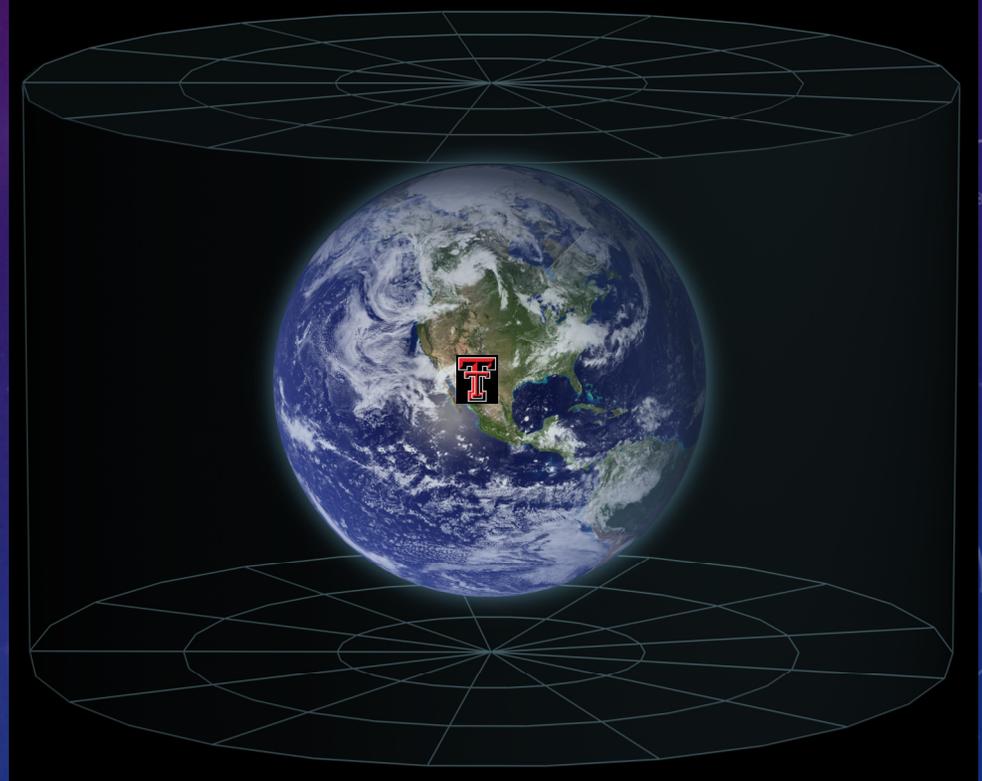
- By Andrew Z. Colvin - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=14358437>

# Location of earth in the universe

## SOLAR SYSTEM



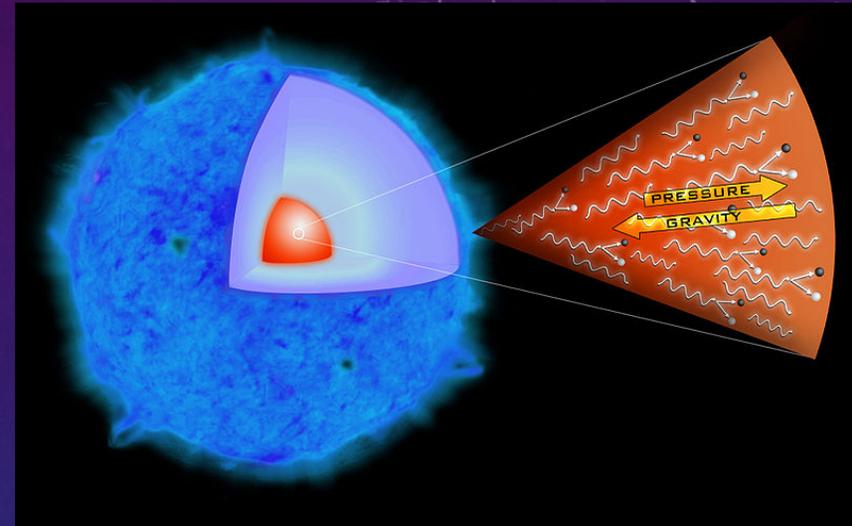
## EARTH



- By Andrew Z. Colvin - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=14358437>

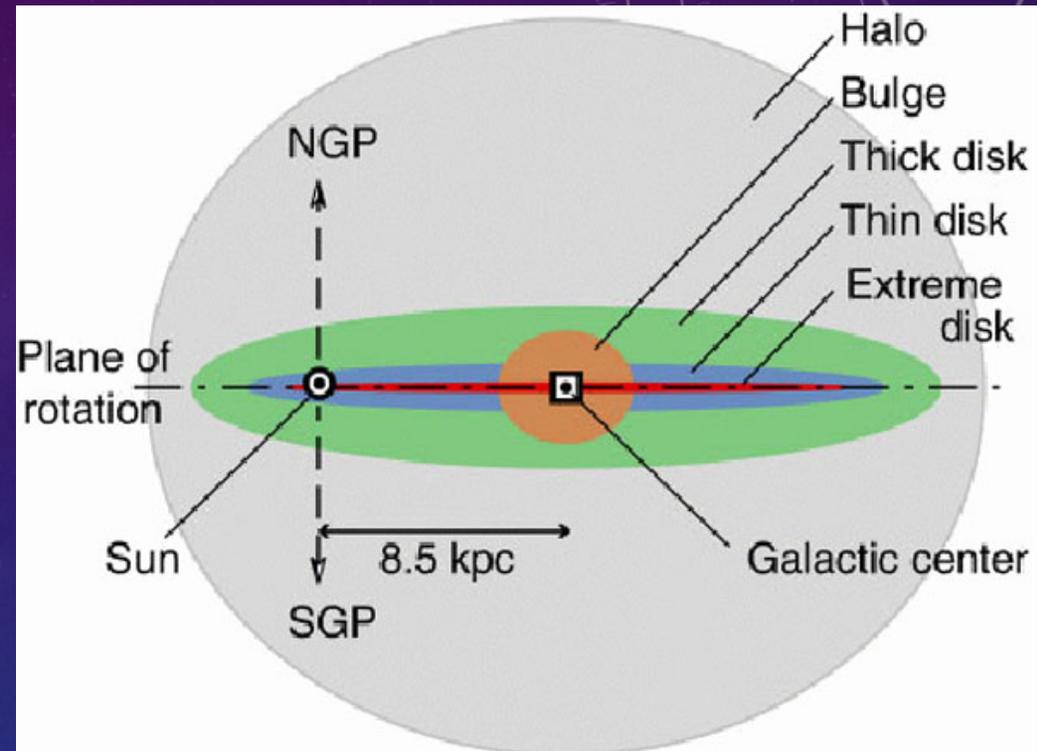
# Population III Stars

- Population III Stars formed resulting from increased matter density due to gravitational force. As mass increases, it increases in temperature and pressure.
  - When the matter becomes hot enough, (around 10 million degrees F) hydrogen nuclear fusion reactions can begin and be sustained
- P III stars have no metals, are thought to be very large (100 to 400 times a solar mass)
  - As a consequence they burned through their fuel in only a few million years (very quickly by comparison to main sequence)
  - collapsed into supermassive black holes and forming (not the first) quasars; created elements heavier than Fe in supernovae



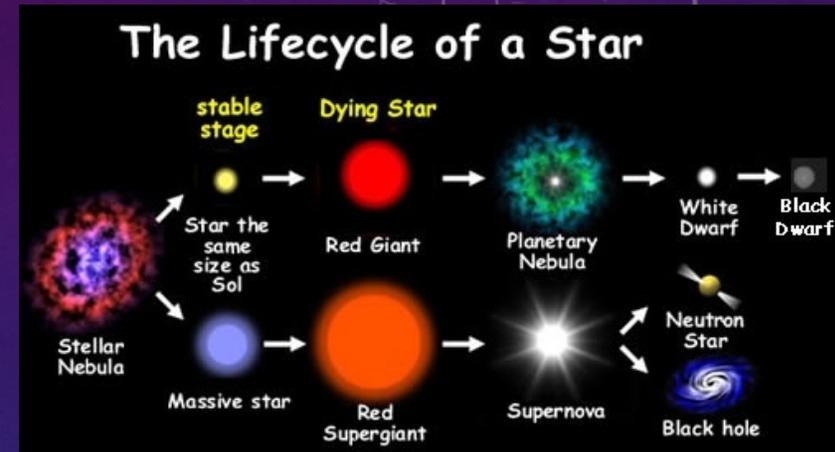
# Population I and II Stars

- Population II Stars have lower metal content as compared to P I stars.
  - They are generally found around the outer rim of galaxies today (older stars); nebulae (stellar nurseries) are near the center
  - Unlike P III, they can be observed today
  - Theory and spectroscopic observations hold that all remaining elements in the periodic chart would be created by P II stars as they supernova.
  - In general, much longer lifespans than P III
- Population I Stars (youngest of all stars)
  - When formed in nebulae, pick up many metals (>Fe) created by previous generations of stars, hence metal rich
  - Our solar system begins to form about 9 BYA BB; more on this shortly...
  - In the meantime, generations of stars are creating heavy metals that are completely necessary for sustaining complex life and seeding nebulae with them.

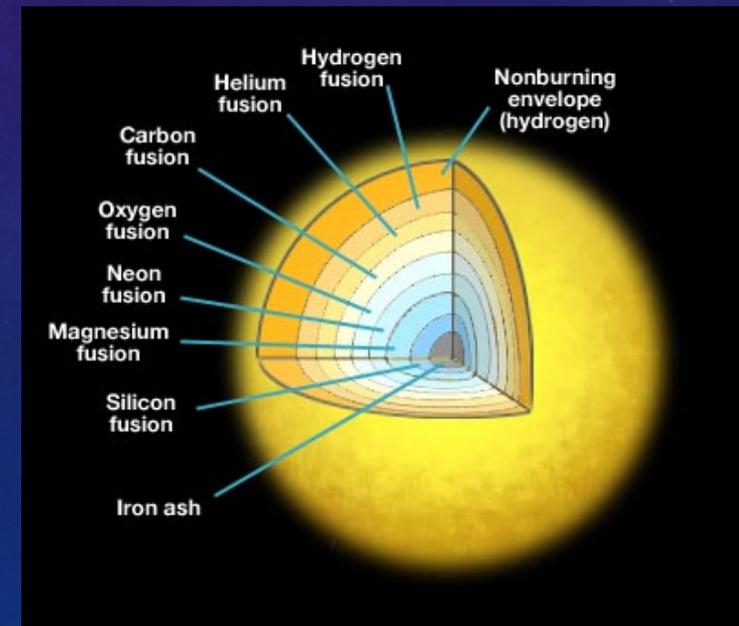


# Life Cycle of Stars

- These supermassive stars produced the first metals (elements heavier than He) in the universe
  - during their fusion (up to iron, element 26) AND
  - subsequent supernovae (possibly up to uranium, element 92)
- As we shall see later, these heavy elements, especially thorium and uranium are absolutely necessary for sustaining complex life on earth.



H B		<table border="1"> <tr> <td>B B</td> <td>L Large stars</td> <td>S Supernovae</td> </tr> <tr> <td>C Cosmic rays</td> <td>S Small stars</td> <td>M Man-made</td> </tr> </table>																B B	L Large stars	S Supernovae	C Cosmic rays	S Small stars	M Man-made	He B									
B B	L Large stars	S Supernovae																															
C Cosmic rays	S Small stars	M Man-made																															
Li C	Be C	B C	C S L	N S L	O S L	F L	Ne S L																										
Na L	Mg L	Al S L	Si S L	P L	S S L	Cl L	Ar L																										
K L	Ca L	Sc L	Ti S L	V S L	Cr L	Mn L	Fe S L	Co S	Ni S	Cu L	Zn L	Ga S	Ge S	As L	Se S	Br S	Kr S																
Rb S	Sr L	Y L	Zr L	Nb L	Mo S L	Tc L	Ru S L	Rh S	Pd S L	Ag S L	Cd S L	In S L	Sn S L	Sb S	Te S	I S	Xe S																
Cs S	Ba L	Hf S L	Ta S L	W S L	Re S	Os S	Ir S	Pt S	Au S	Hg S L	Tl S L	Pb S	Bi S	Po S	At S	Rn S																	
Fr S	Ra S	La L	Ce L	Pr S L	Nd S L	Pm S L	Sm S L	Eu S	Gd S	Tb S	Dy S	Ho S	Er S	Tm S	Yb S L	Lu S																	
		Ac S	Th S	Pa S	U S	Np S	Pu S	Am M	Cm M	Bk M	Cf M	Es M	Fm M	Md M	No M	Lr M																	





Sol System  
(our Sun)

## Milky Way Galaxy

- Galaxies with spiral arms (SG) are very rare
  - Is the only type able to support complex life
  - Ellipsoidal and Spherical galaxies contain mostly older stars and formation is relatively rare causing a significant shortage and diversity of heavy metals
    - Stars are often in congested areas where stable, long term orbits are very rare.
  - Maintaining spiral structure is a complex topic, but it requires the presence of dwarf galaxies to accrete gas and the absence of nearby super large galaxies that may accrete from the spiral galaxy or perturb orbits gravitationally
  - MWG is the right size for life on earth
    - Co-rotation radius – distance from galactic center at which stars revolve around the galactic center at the same rate as the galactic arms
    - Larger SG (longer CRR) too far out to have sufficient abundance of essential heavy metals
    - Smaller SG (shorter CRR) places the planet too close to the galactic center with exposure to deadly gamma and cosmic radiation; gravitational interference with other spiral arms

Source: Ross, H. (2016). *Improbable Planet*. Grand Rapids, MI: Baker Books.



Sol System  
(our Sun)

## Milky Way Galaxy

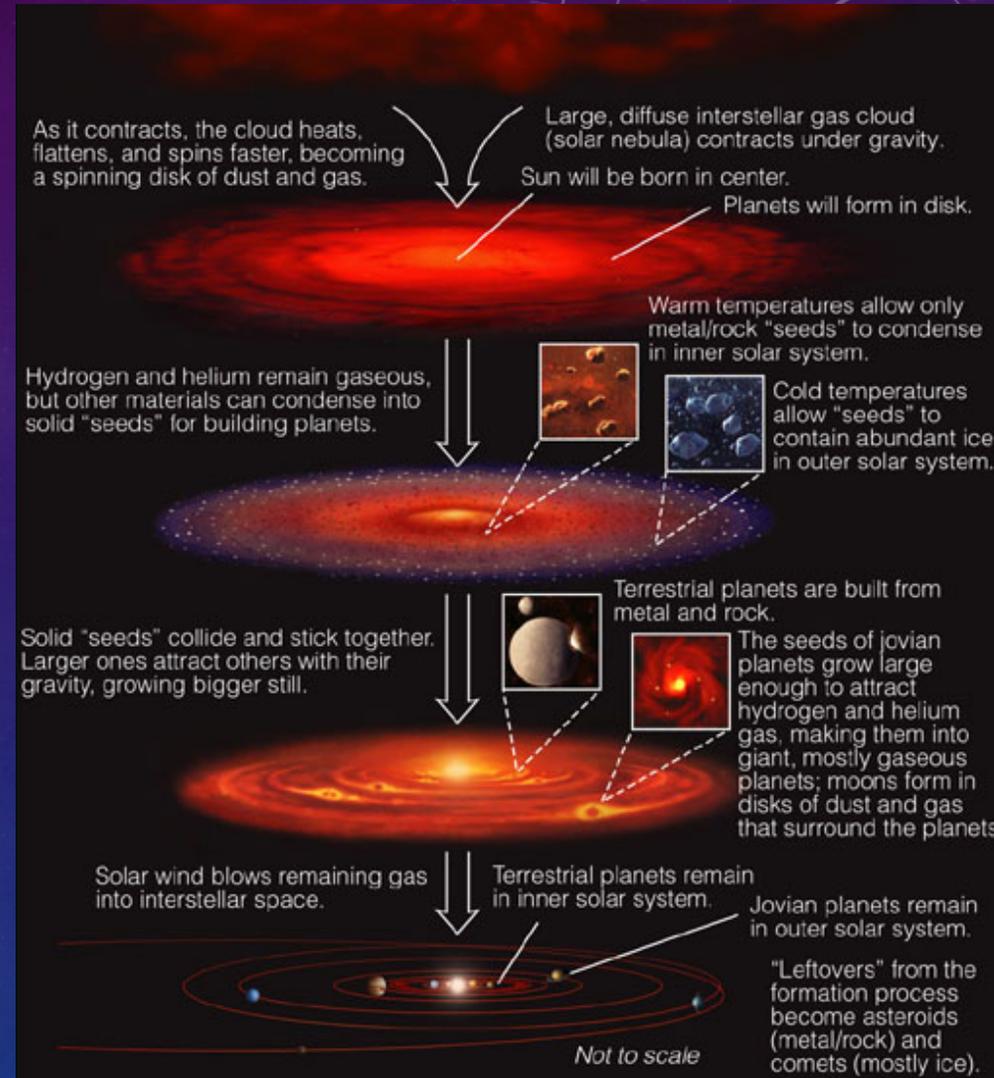
- Galaxies with spiral arms (SG) are very rare
  - Our solar system migrated outward after initial formation to
    - A location that within the Orion spiral
    - At this location, stars do not drift in and out of the spiral arms as the arms rotate about the center
    - Stars with their large gravitational wells would disturb the orbits of smaller objects (like earth) resulting in destruction of complex life
    - This location also affords us a view of the galactic center, neighborhood and universe at large, this is necessary for exploration

Source: Ross, H. (2016). *Improbable Planet*. Grand Rapids, MI: Baker Books.

# Solar System Formation: 8.5 – 9B years after BB; 4.5 – 5 BYA

## BYA

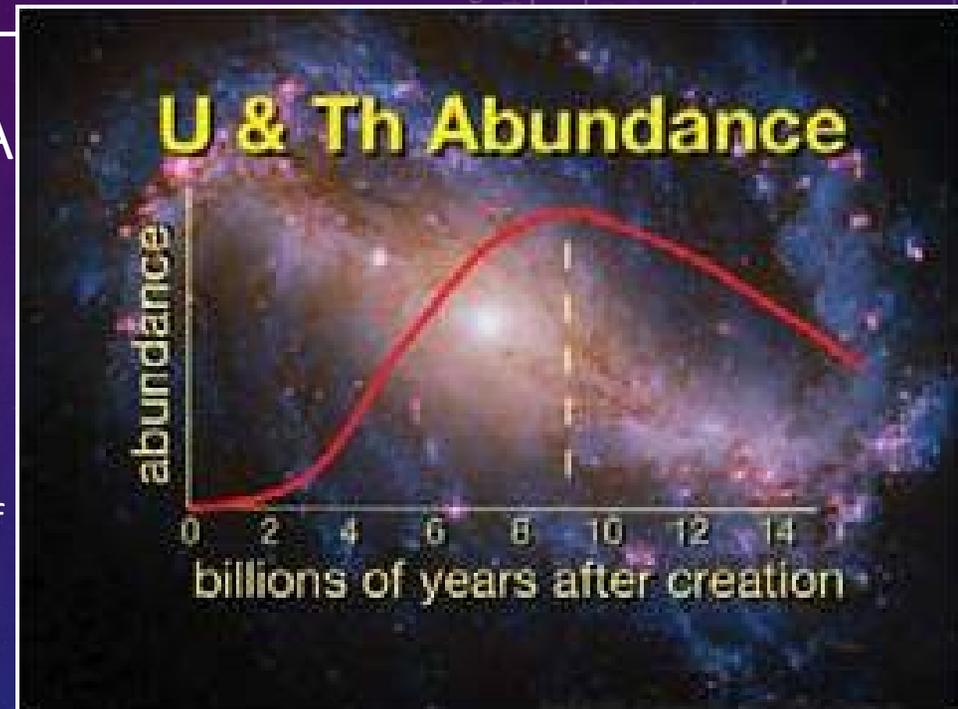
- Infographic shows the process currently understood for the development of our solar system...
- Today the solar system orbits just inside the CR distance in a stable part of the galaxy
- The solar system must have originated at a point much closer to the galactic center as evidenced by the abundance of metals in our solar system (specifically heavy radioisotopes) and earth.
- Early stars that were supernovae expelled large quantities of metal rich gases into surrounding void
  - later generation stars and nebulae formed with these materials
- Apparently, the solar system formed in the just right proximity to several large supernovae that provided heavy elements and drove off vast quantities of light elements



Copyright 2004 Pearson Education, publishing as Addison Wesley

# Solar System Formation: 8.5 – 9B years after BB; 4.5 – 5 BYA

- With respect to other observations made in the milky way, earth's crust has greater relative abundances (by mass) of several metals and heavy metals compared to other solar systems observed (spectroscopic techniques)
- The solar system formed at a time in history when Thorium and Uranium would have been at their peak abundances (chart)
- The sun and the new planets could not stay in their place of creation, they had to move to a quieter place...
  - The trajectory had to take it away from the center of the galaxy with a very gentle nudge so as not to disturb orbits
  - Z-motion must be <500 LY, if greater, the solar system would be exposed to lethal levels of radiation from the core that would prevent complex life to exist later
  - Actual solar z-motion is about +/- 228 LY

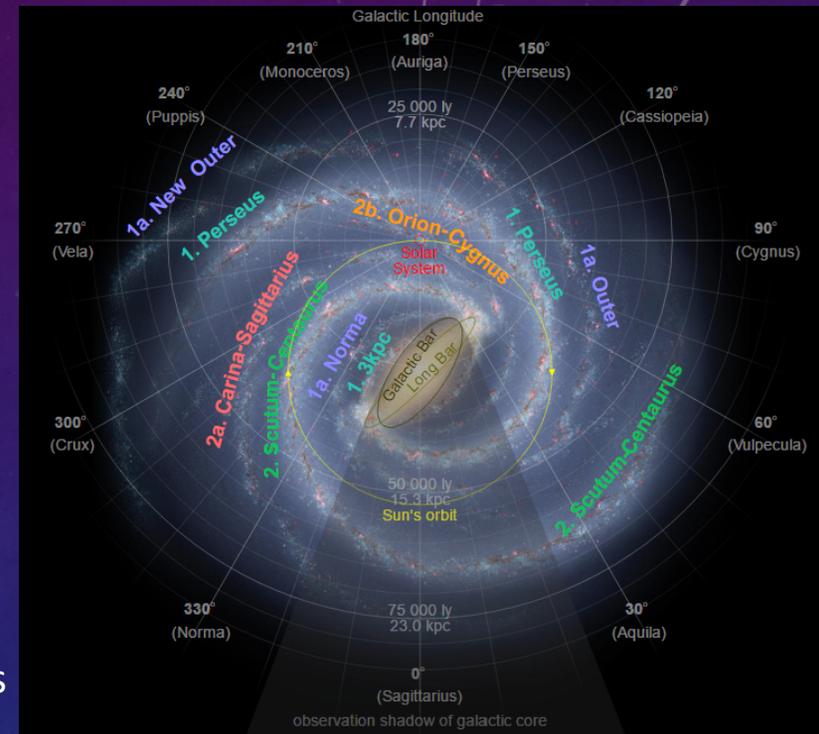


Source:

<http://www.reasons.org/articles/elemental-evidence-of-earths-divine-design>

# Solar System Formation: 8.5 – 9B years after BB; 4.5 – 5 BYA

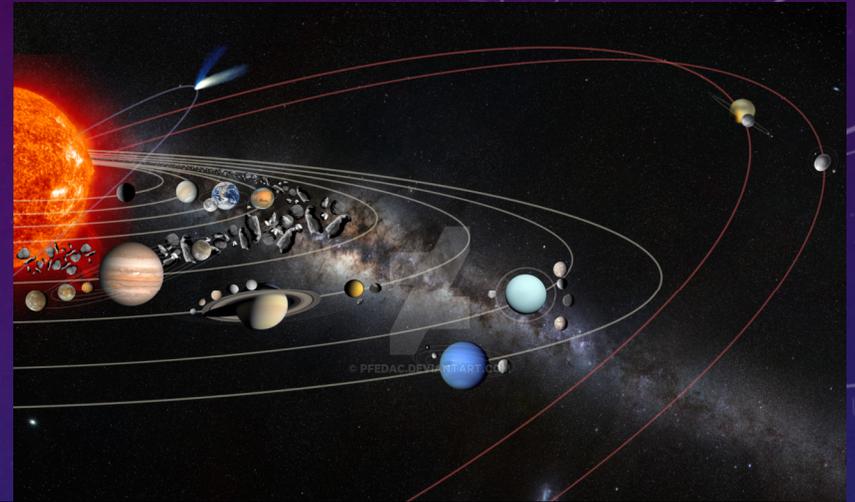
- The final radius and orbit of the solar system around the galactic center is not certain
- Radius does vary to some extent, though not certain of extent
- The new orbit is in a “quiet neighborhood”
  - No nearby objects to disturb planetary orbital trajectories
  - No nearby bright stellar objects to obscure observation of the galaxy and universe
  - Protected from the high intensity radiation from the galactic center
  - Just when things were looking pretty good...



Artists conception of galactic orbit  
source  
[https://en.wikipedia.org/wiki/Galactic\\_year](https://en.wikipedia.org/wiki/Galactic_year)

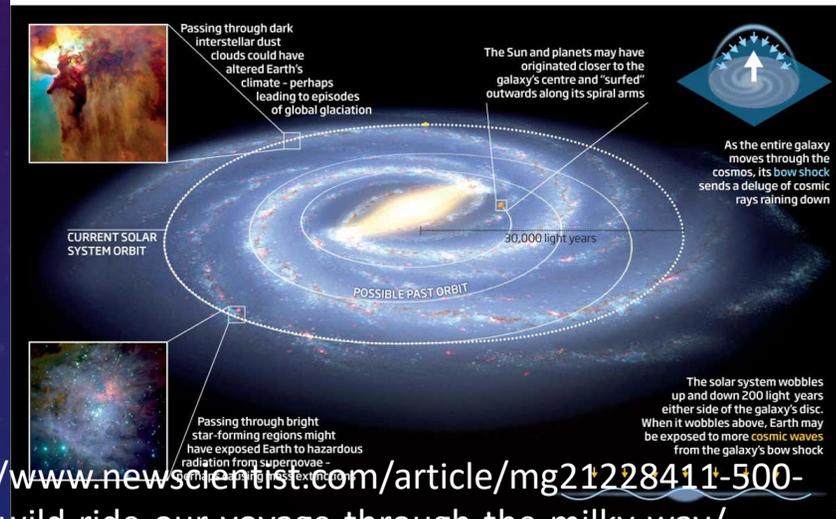
# Solar System Dynamics - Gas Giants

- Provide effective protection for the inner rocky planets from objects outside the solar system or from Kuiper belt / Oort cloud



## Our way through the Milky Way

The solar system is travelling at a steady 220 kilometres per second in a circular orbit around the centre of the galaxy - but it might not always have done so



<https://www.newscientist.com/article/mg21228411-500-earths-wild-ride-our-voyage-through-the-milky-way/>

# Solar System Dynamics - Gas Giants

- Gas giant gravitational well will either accelerate and deflect incoming objects or draw them into a collision
- If gas giants are too small or too distant they will be ineffective
- If they are too large or too close they will disrupt the orbits of the inner planets where complex life must exist
- All four gas giants, Jupiter, Saturn, Uranus and Neptune have optimal sizes, orbits and distances from the sun to minimize the number of collisions from extra solar objects

Source: Ross, H. (2016). *Improbable Planet*. Grand Rapids, MI: Baker Books.

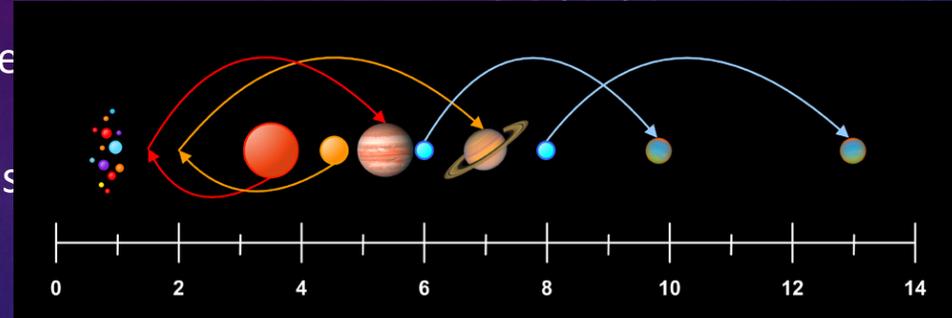
[Solar System Formation 6min](#)

Source:  
[https://www.youtube.com/watch?v=M8AzsbtII\\_k](https://www.youtube.com/watch?v=M8AzsbtII_k)



# Solar System Dynamics - The Grand Tack

- In order to account for orbits of earth, mars and the size of the asteroid belt observed today, Jupiter and Saturn did something unique.
- Current observations of exoplanets show most gas giants are very close to their star as a result of inward migration
- Planetary models predict mars should be 50% more massive than earth and that the asteroid belt should be 2000 times more massive than observed
  - This results in many more asteroids being gravitationally slung towards earth causing many more catastrophic collisions on the surface
- All solar system models agree that Jupiter was the first GG to form and afterwards, enough mass persisted to cause an inward migration to begin



Source:

<http://backalleyastronomy.blogspot.com/2012/07/solar-system-archaeology-part-ii.html>



# THE GRAND TACK

Jupiter's zigzagging path through the fledgling Solar System

## APPROX 4.6 BILLION YEARS AGO: T=0

Jupiter forms near the 'ice line' in the protoplanetary disc, between its rocky inner parts and icy outer parts. The other large planets are also beginning to condense out.

THE SUN



## T=70,000 YEARS

The 'drag' of the protoplanetary material causes Jupiter to migrate inwards, pushing much of the rocky material into the Sun.



## T=100,000 YEARS

Saturn follows Jupiter inwards, almost catching up with it and halting their inward movement. In the process, some icy asteroids are dragged into the inner Solar System.



## T=300,000 YEARS

Jupiter and Saturn migrate back outwards, leaving behind a mixture of rocky and icy debris from which the inner planets will form.



## T=500,000 YEARS

At the end of the Grand Tack, Jupiter is near its present position - but the outer planets are still much closer to the Sun than they are today.



## APPROX 4.5 BILLION YEARS AGO

Now the inner planets have formed too, close to their present positions. After another half a billion years, Uranus and Neptune will migrate outwards to their final positions.



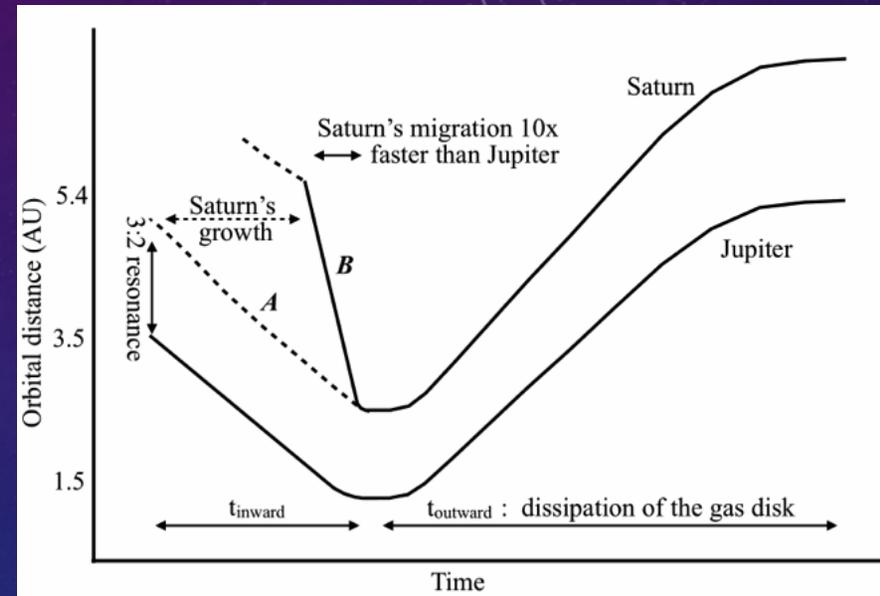
2 AU

4 AU

XXXXX

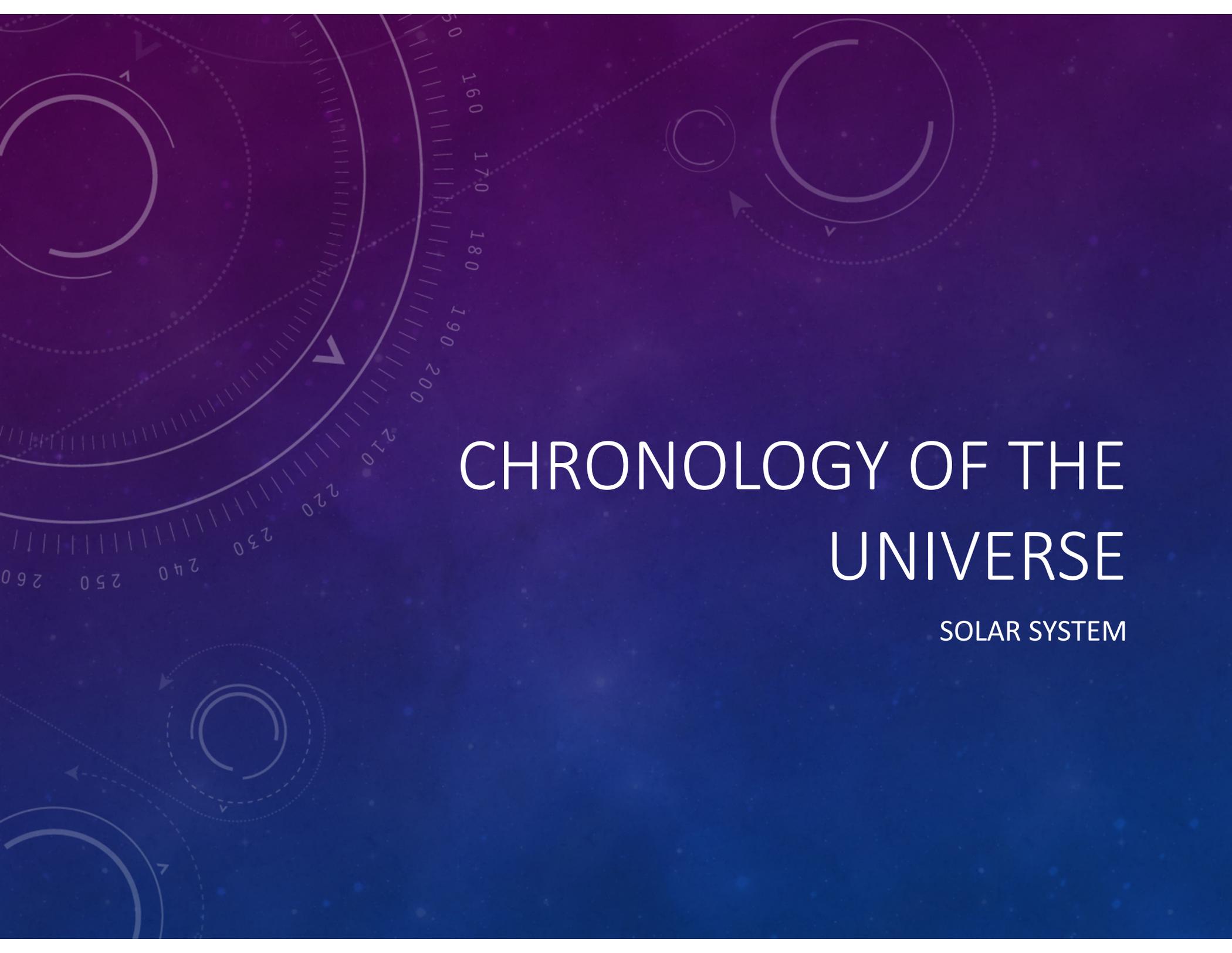
# Solar System Dynamics - The Grand Tack

- As Saturn approached its final mass and position, it also began to migrate inward but at a faster rate
- Both planets continued their inward migration until they reached a 3:2 gravitational orbital (mean motion) resonance condition
  - From the perspective of the sun, the masses of Saturn and Jupiter add together to create a much more massive “virtual” planet that has enough angular momentum to recede from the sun
- The inward migration and recession results in a significant thinning of the asteroid belt and, removes material that Mars could have used to increase its mass
- Other models have corroborated the same results
- Long term complex life on earth is possible as a result of the gas giants and is not possible without them



Source: [http://www.obs.u-bordeaux1.fr/e3arths/raymond/movies\\_grandtack.html](http://www.obs.u-bordeaux1.fr/e3arths/raymond/movies_grandtack.html)

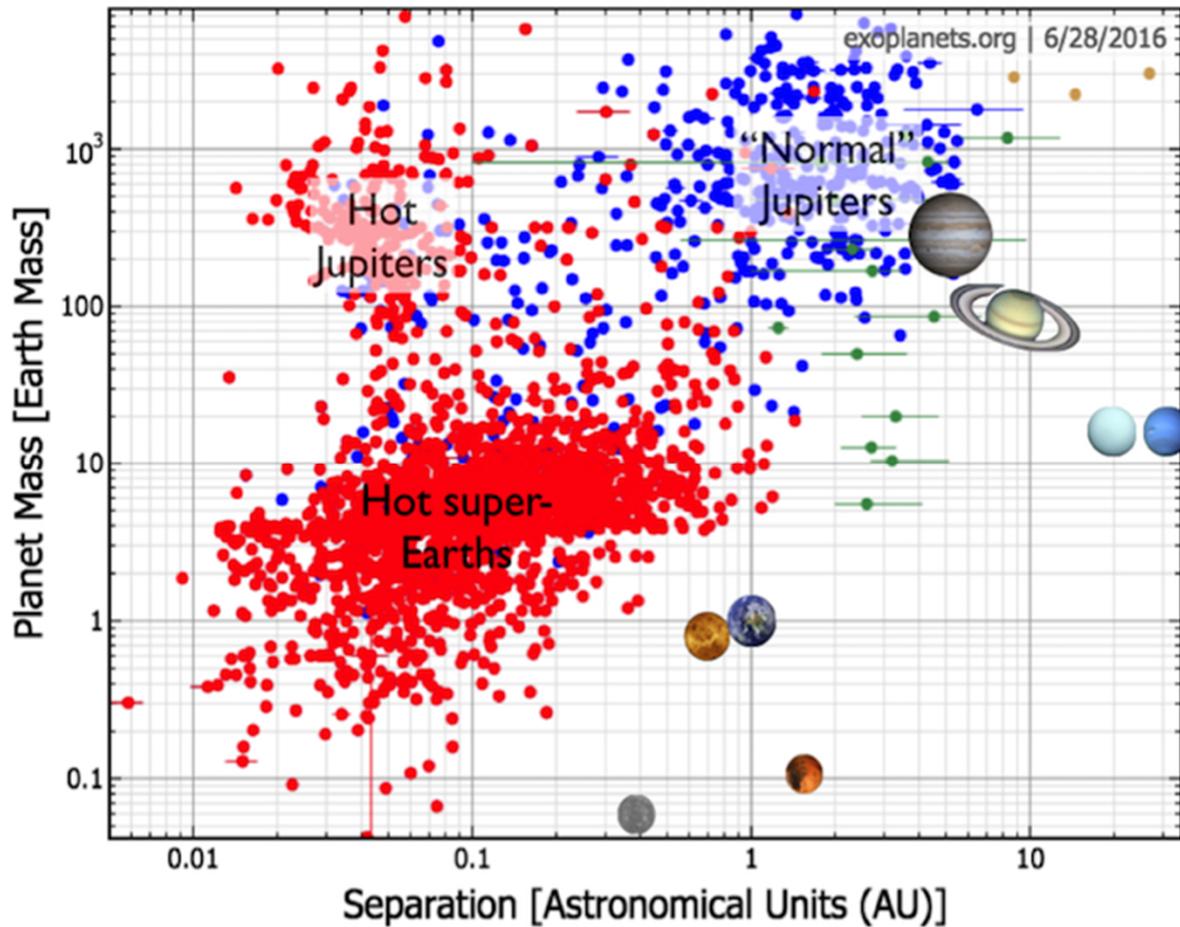
Ross, H. (2016). *Improbable Planet*. Grand Rapids, MI: Baker Books.



# CHRONOLOGY OF THE UNIVERSE

SOLAR SYSTEM

# Solar System Comparison to exoplanets discovered so far



- X axis shows distance from the sun and the Y axis show mass
- For reference earth is 1 AU and 1 earth mass
- In comparison to other solar systems, ours seems to be quite unique as ideally suited for complex life

Source:

<https://planetplanet.net/2016/07/12/exactly-how-unusual-is-our-solar-system/>

# Solar System Dynamics - The Moon Forming Event

- About 4.5 BYA, Earth was hypothesized to be a molten world with a thick atmosphere similar to Venus today
- Most widely accepted explanation of how the moon formed is that a mars sized object (Theia, about 20% mass of earth) collided with earth
- Models show and the laws of physics allow a second planet to accrete and coalesce at a LaGrange point close to earths orbit and eventually overtake earth through gravitational interactions with Venus
  - Impact at about a  $45^{\circ}$  angle with a relative velocity of 12 km/sec
  - The light elements would have been blown into local space while the two heavy metal cores would have merged into one
- The lighter ejected products would have later coalesced into the moon while the heavier materials would have collected back to earth



Source:

<http://www.universetoday.com/19718/formation-of-the-moon/>

Ross, H. (2016). *Improbable Planet*. Grand Rapids, MI: Baker Books.

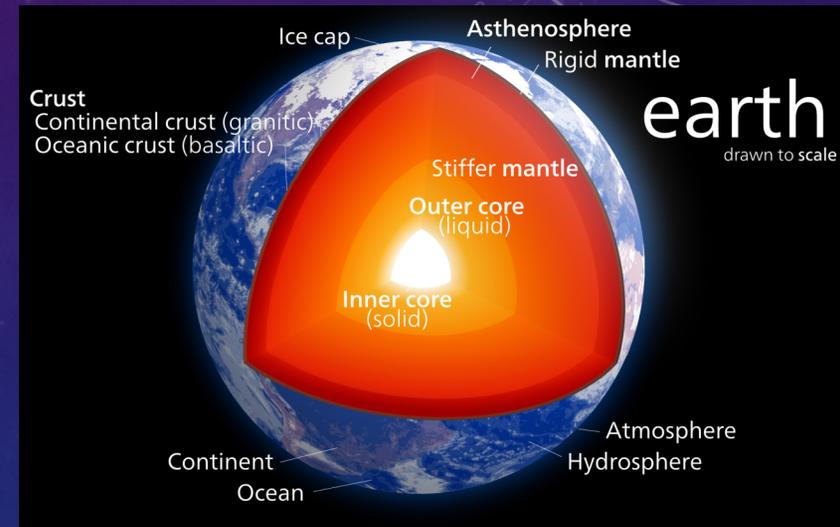
[Moon Forming Simulation 1:30](#)

Source:

<https://www.youtube.com/watch?v=PnhfLL7-I3I>

# Solar System Dynamics - The Moon Forming Event

- The collision enveloped Theia and turned Earth into a molten ball; in this “liquefied” state, many of the heavy elements sank into the inner and outer cores of earth
- Implications of the collider event
  - Replacement of earth’s thick atmosphere with one more optimal for later complex life chemically
  - Earth’s atmosphere went from being opaque to translucent and later to transparent after  $O_2$  was introduced in the atmosphere
  - Mass and density of earth were augmented to retain water vapor (MW 18), while allowing  $NH_3$  (MW 17) and  $CH_4$  (MW 16) to escape the atmosphere



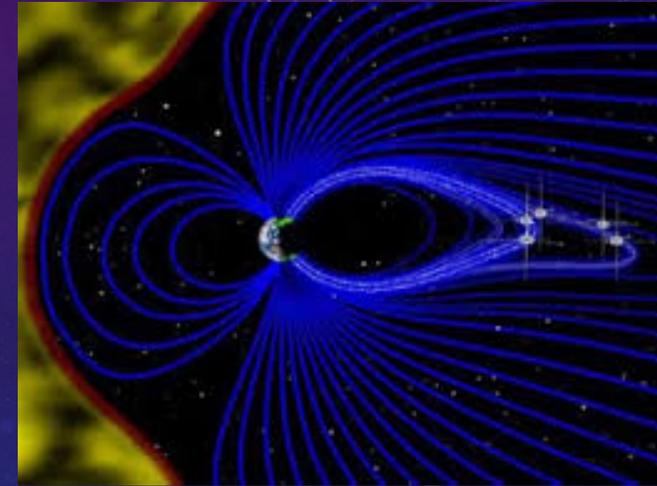
Source:

<http://www.universetoday.com/19718/formation-of-the-moon/>

Ross, H. (2016). *Improbable Planet*. Grand Rapids, MI: Baker Books.

# Solar System Dynamics - The Moon Forming Event

- Implications of the collider event (cont)
  - The collision event likely provided the kinetic energy to kick start the dynamo in the core but heat from radioactive decay of heavy elements provides the heat energy required to maintain
  - Significant increases in Fe & Ni content in the core allowing liquefied metal dynamo to create a strong magnetic field around the earth
    - Shields the earth from solar winds (charged particles like protons, electrons thrown out from the sun)
    - Coronal Mass Ejections (CMEs - charged particles like protons, electrons thrown out from the sun)
    - Prevents atmospheric sputtering by solar winds (Mars)



Source: Ross, H. (2016).  
*Improbable Planet*. Grand  
Rapids, MI: Baker Books.

[Magnetosphere & Magnetopause 2 min](#)

# Solar System Dynamics - The Moon Forming Event

- Implications of the collider event (cont)
  - Provided sufficient abundance of long lasting radioisotopes (U-238 HL 4.5 BY and Th-232 HL 14 BY) that provide the energy to drive volcanism and plate tectonics
  - The moon had enough mass, proximity, and angular velocity (momentum and gravity) to stabilize earth's tilt and slow earth's rotation rate
    - After the collision, earth nutated (wobbled) on its axis
    - Earth's rotation time was about 6 hours, far too fast to allow complex life; 500 mph surface winds
    - The moon's size and initial proximity provided nutation stabilization and reduced angular momentum (rotation speed) over time.



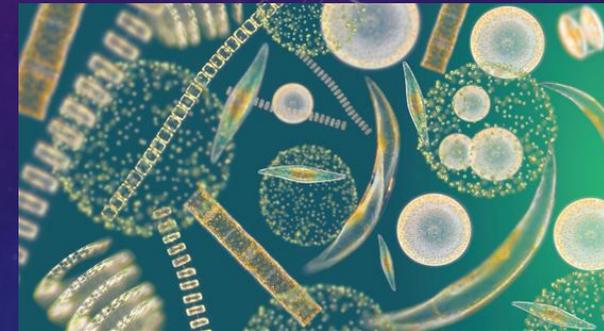
Source:

<https://images.newscientist.com/wp-content/uploads/2016/09/14151451/webresize-112717163.jpg?width=800>

Ross, H. (2016). *Improbable Planet*. Grand Rapids, MI: Baker Books.

# Solar System Dynamics - The Moon Forming Event

- Implications of the collider event (cont)
  - Phytoplankton (created later) are ocean dwelling photosynthetic organisms that require Fe,
    - Form the basis of the aquatic food chain and require Fe and other metals in their metabolic processes
    - Are the largest source of atmospheric oxygen on the planet required for long term advanced life
  - Provided sufficient abundance of long lasting radioisotopes (U 238 HL 4.5 BY and Th HL 14 BY) that provide the energy to drive volcanism and plate tectonics.



Source:

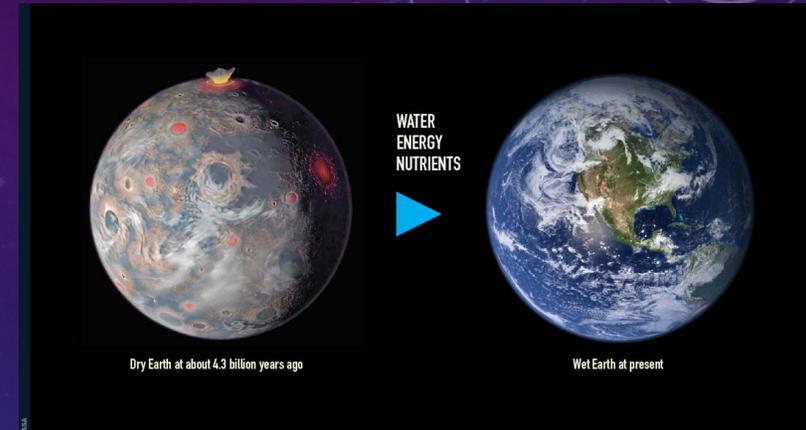
<http://sailorsforthesea.org/programs/ocean-watch/searching-phytoplankton>

Ross, H. (2016). *Improbable Planet*. Grand Rapids, MI: Baker Books.

# Late Heavy Bombardment 4.2

## – 3.8 BYA

- The image shows what the earth is believed to have looked like after the moon collider event; there was a thin atmosphere and no water
- It wasn't until after the merger event that earth had enough mass to retain water vapor in its atmosphere
- So where did our water come from?
- Going back to the gas giants for a moment....
  - Detailed solar computational models show that when Saturn and Jupiter reached its 2:1 gravitational resonance...
  - This condition created a gravitational disturbance that caused Uranus and Neptune to change places and move outward
  - These in addition with other possibilities caused LHB to begin



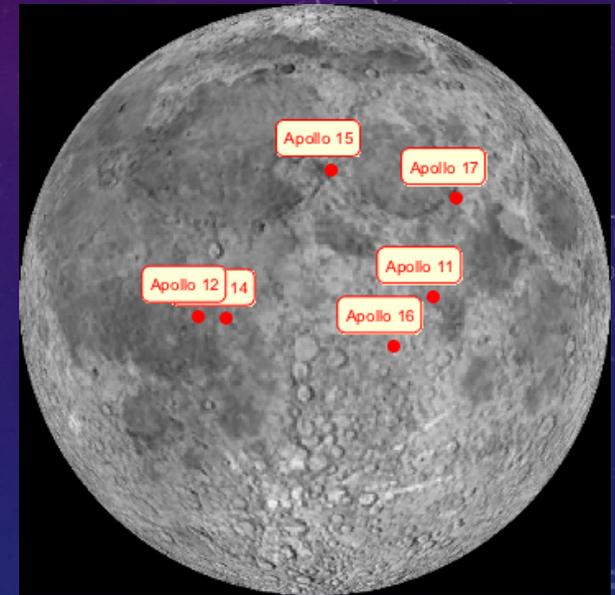
source

<http://astrobiowalk.gsfc.nasa.gov/5.html>

# Late Heavy Bombardment 4.2

## – 3.8 BYA

- Nice Models indicate that predominately Kuiper belt objects would have been hurled inward toward the rocky planets (lots of ice out there)
- Radiometric dating of lunar rocks returned from Apollo missions confirm the ranges
- From studies of the lunar craters and assuming a consistent probability, the following can be extrapolated for earth
  - Appx 22,000 impact craters > 12 miles
  - Appx 40 impact craters > 620 miles
  - Several (3) impact craters up to 3,100 miles
- The bombardment is necessary for bringing water to the planet



source

<http://astrobiowalk.gsfc.nasa.gov/5.html>  
[https://en.wikipedia.org/wiki/Late\\_Heavy\\_Bombardment](https://en.wikipedia.org/wiki/Late_Heavy_Bombardment)

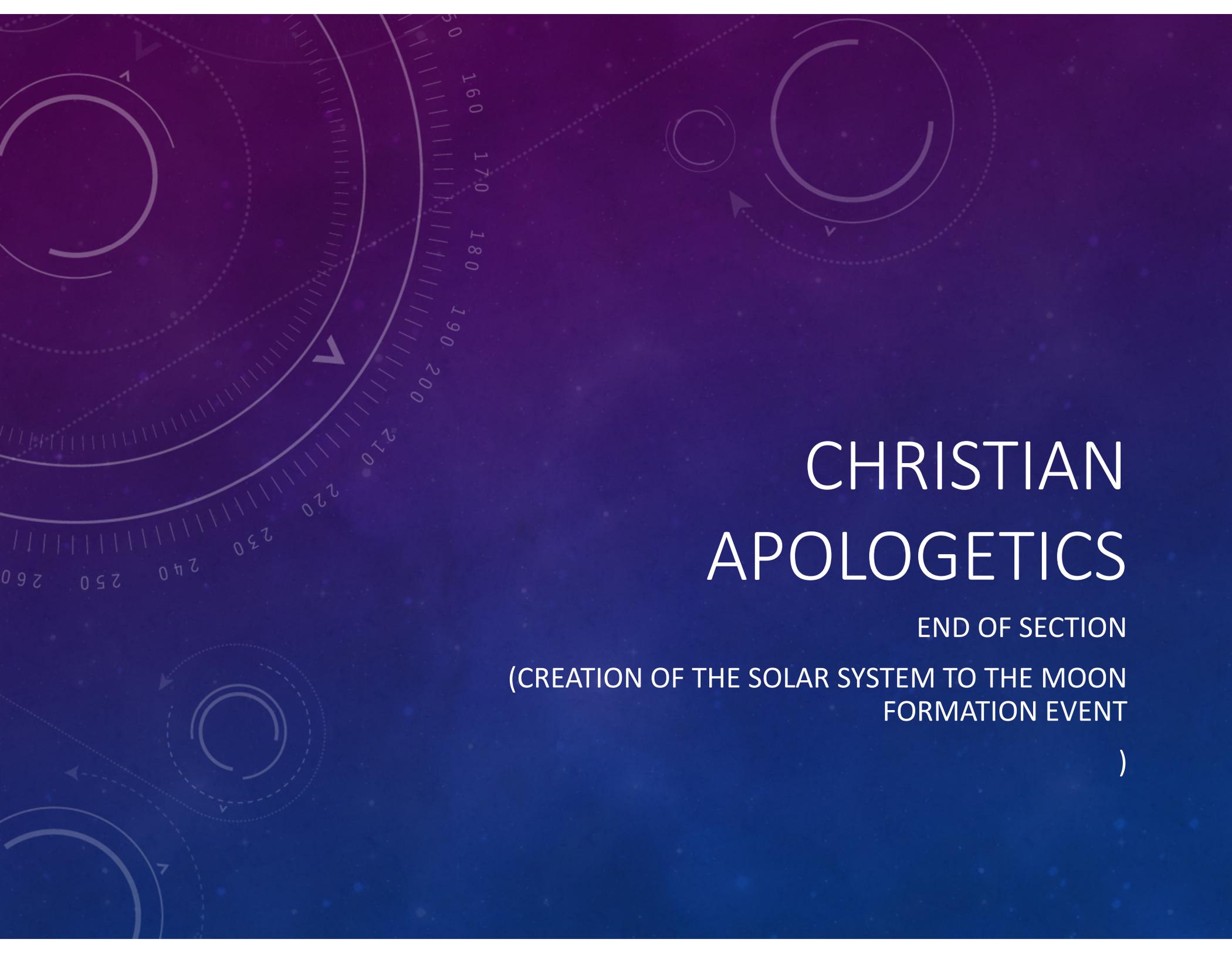
# Late Heavy Bombardment 4.2

– 3.8 BYA

- Iridium enrichment levels found in metasedimentary rocks dated 3.8 BY is consistent with enrichment levels found in lunar samples of the same age...
  - On average 7.5x higher than in crustal levels
- Some have speculated hyperthermophile life (HTL) forms may have existed however there is no evidence to support this, for example
  - Ribose (5 carbon sugar base) of DNA/RNA, in a pH neutral solution
  - Concentrations would not be high enough spawn any reasonable abiogenesis scenario
  - Additionally, gamma radiation due to radioactive decay would have been 5 times its present value measured today
- Minimum conditions for even primitive life are not yet met



Source: Ross, H. (2016). *Improbable Planet*. Grand Rapids, MI: Baker Books.

The background features a dark blue gradient with faint, glowing circular patterns and a scale. The scale is a semi-circular arc on the left side, with numerical markings from 160 to 260 in increments of 10. There are also several concentric circles and dashed lines with arrows, suggesting a technical or scientific theme.

# CHRISTIAN APOLOGETICS

END OF SECTION

(CREATION OF THE SOLAR SYSTEM TO THE MOON  
FORMATION EVENT

)