

Introduction to Astronomy



- Astronomy is the scientific study of planets, stars, galaxies, and the entire universe.



- It fuels curiosity, advances technology, improves navigation, and shapes our calendars.



- NASA spinoffs include memory foam, scratch-resistant lenses, and medical imaging tools.



- This course visually tours the solar system, stars, galaxies, and how to observe the sky.

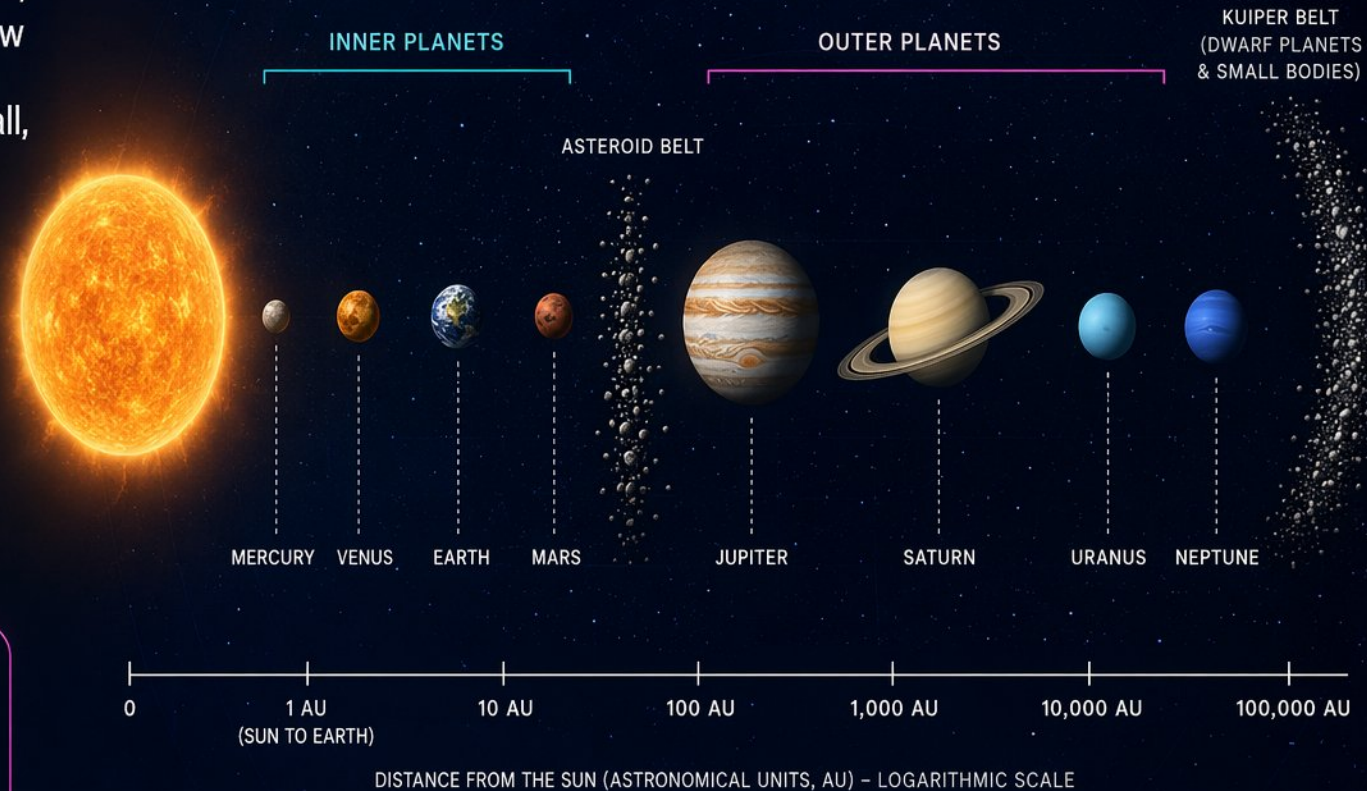


- Stay curious: ask questions, use resources, and step outside to look up.



The Scale of Our Solar System

- The Sun, eight planets, asteroid belt, and Kuiper Belt in one to-scale view
- Visual analogy: Sun as a basketball, Earth as a peppercorn
- Two families: small, rocky inner planets vs. large, gaseous/icy outer planets
- Beyond planets: dwarf planets, moons, rings, and comets are key components



SUN AS A BASKETBALL



EARTH AS A PEPPERCORN



DWARF PLANETS
Including Pluto, Eris, Haumea, Makemake, Ceres



MOONS
Hundreds orbit the planets and dwarf planets



RINGS
Prominent around Jupiter, Saturn, Uranus, and Neptune



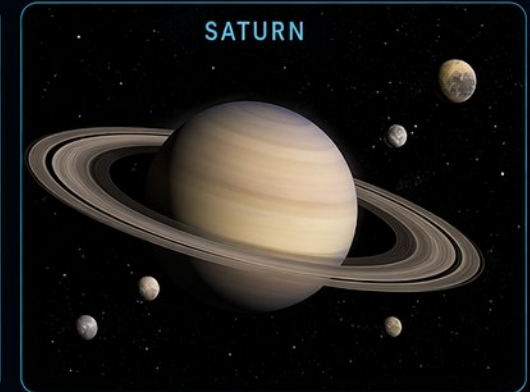
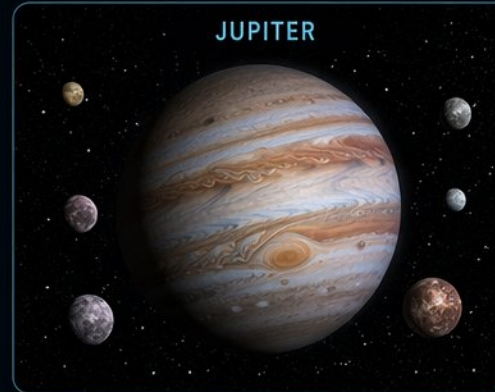
COMETS
Icy bodies from the Kuiper Belt and Oort Cloud

A System of Worlds:

Moons, Rings, and Dwarfs

- Jupiter and Saturn each have swarms of newly discovered moons
- A tiny 10-km moon, S/2025 U1, was found near Uranus's rings by JWST in 2025
- Dwarf planets like Pluto and Quaoar form a distinct planetary category
- Quaoar and Chariklo host ring systems that challenge old ring dynamics

GIANT PLANETS & THEIR MOONS



NEW DISCOVERY NEAR URANUS



DWARF PLANETS & RING SYSTEMS



Ring systems around Quaoar and Chariklo challenge old ring dynamics.

The Sun: Our Nearest Star

- The Sun is a star, composed mostly of hydrogen and helium
- **Layers:** core, radiative zone, convection zone, photosphere, chromosphere, corona
- 11-year sunspot cycle drives flares, coronal mass ejections, and solar wind
- Solar activity creates aurorae and can disrupt satellites and power grids



Core



Radiative
Zone



Convection
Zone



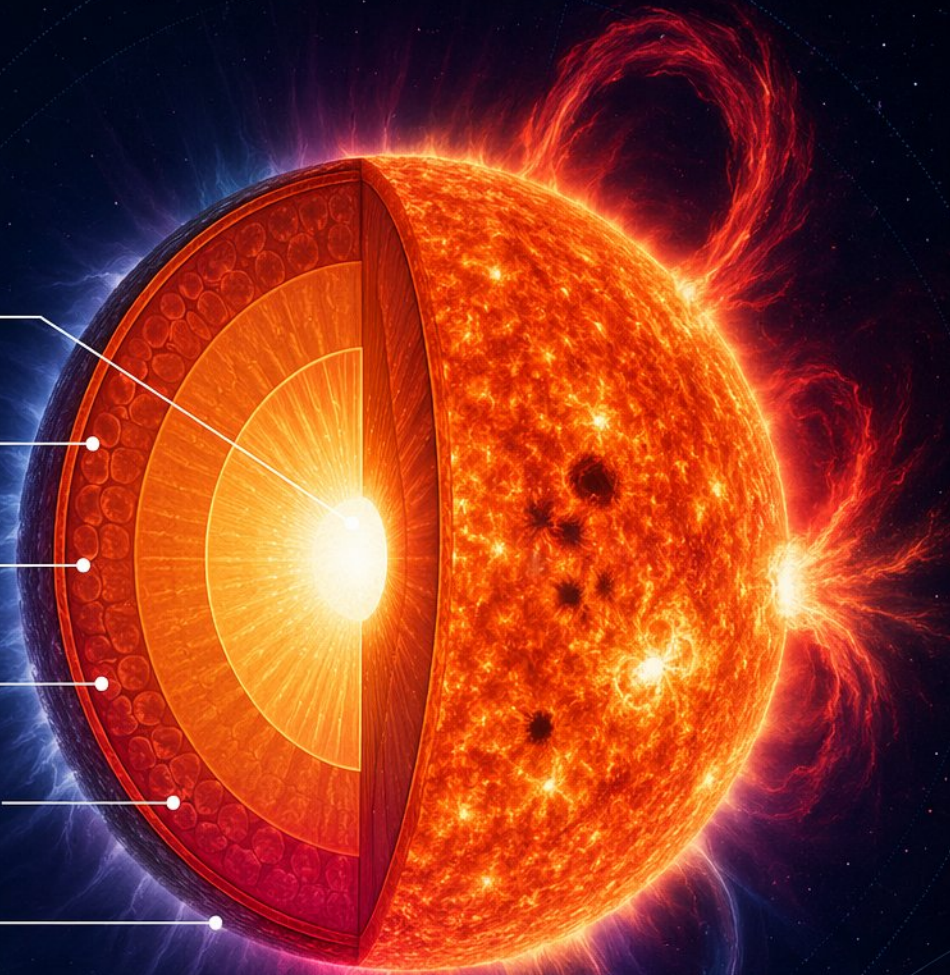
Photosphere



Chromosphere



Corona



SUNSPOT
CYCLE
~11 YEARS



SOLAR
FLARES



CORONAL MASS
EJECTIONS



SOLAR
WIND

Solar Cycle 25 in Action



- Currently in Solar Cycle 25, reaching its maximum phase



- X9.0 flare in October 2024: largest of the cycle so far



- G4 geomagnetic storm on November 12, 2025, from multiple X-class flares



- January 2026 storm and Forbush decrease: among the most significant in decades



- Strong solar storms and vivid auroras still possible into 2026

SOLAR FLARE INTENSITY (GOES X-RAY FLUX)

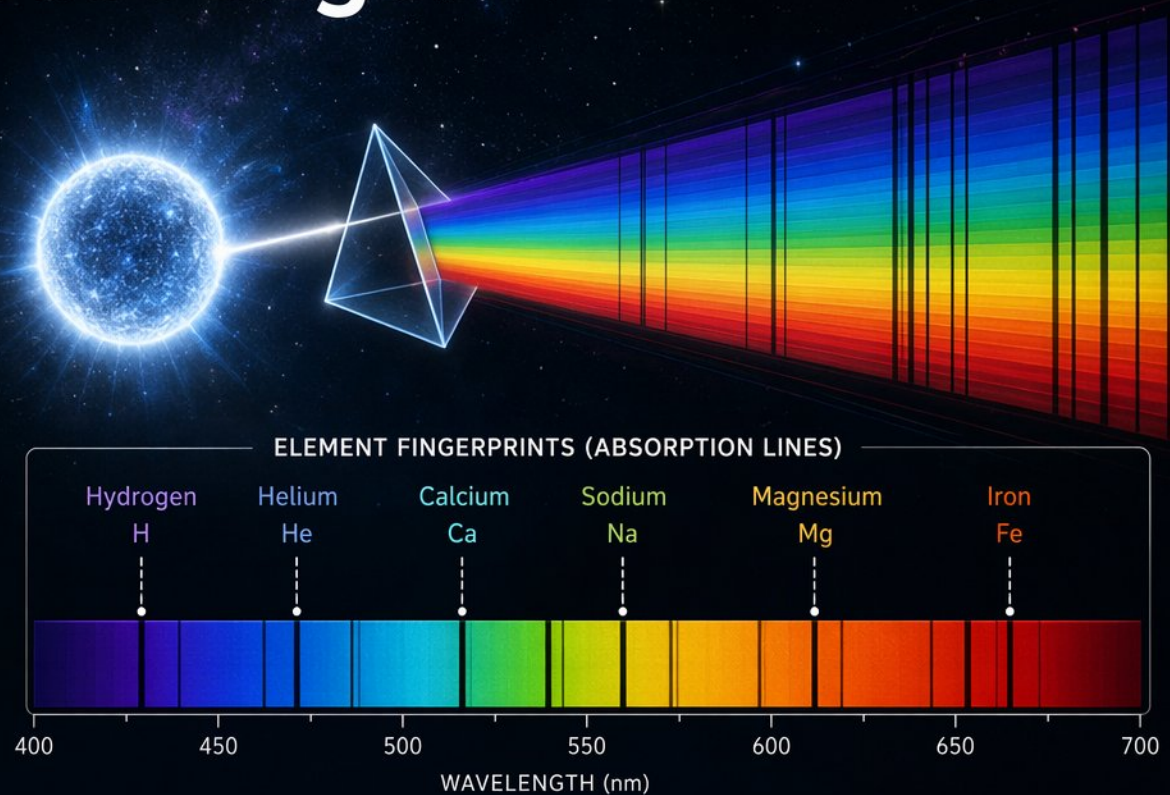


GEOMAGNETIC STORM INDEX (NOAA Kp)

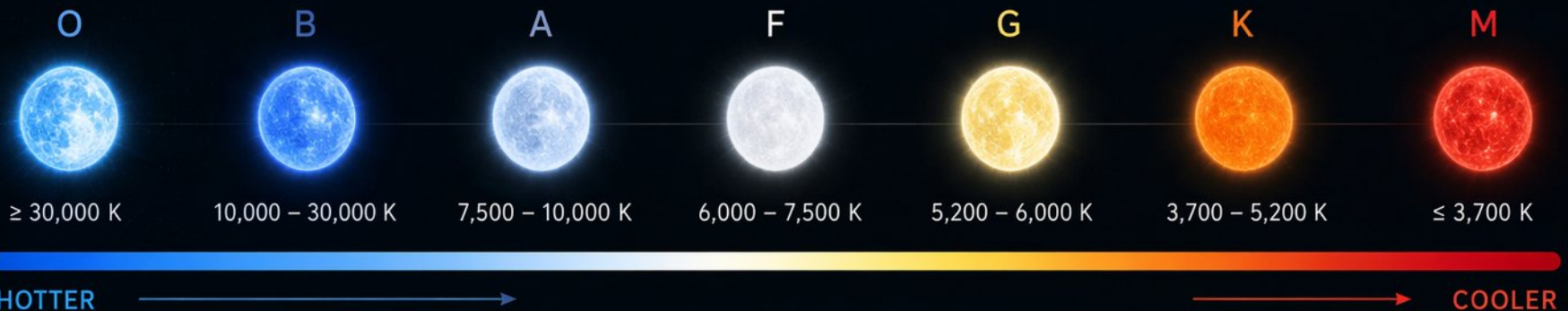


Starlight as a Messenger

- Starlight reveals temperature, composition, and motion
- Spectroscopy splits light into element fingerprints
- Blue stars are hot; red stars are cool
- Spectral sequence O B A F G K M maps temperature



SPECTRAL SEQUENCE AND TEMPERATURE



Cosmic Distance Ladder

- Apparent brightness is how bright a star looks; absolute brightness is its true power
- Parallax: a star's tiny apparent shift reveals distance to nearby stars
- Standard candles: Cepheid variables and Type Ia supernovae measure vast cosmic distances
- Each rung calibrates the next, stepping from nearby stars to distant galaxies



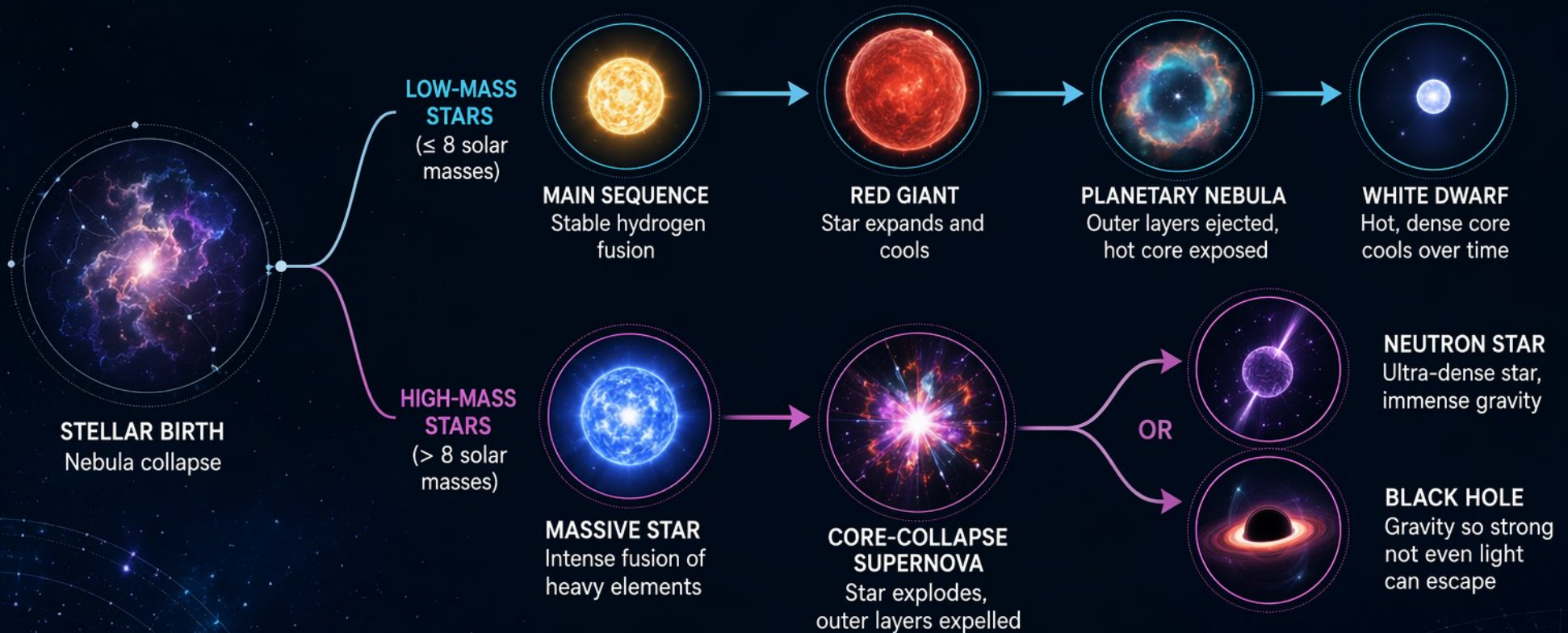
The Birth of Stars

- Cold, dense nebula collapses under gravity to form a protostar
- A true star ignites when core fusion turns hydrogen into helium
- Main sequence: the longest, most stable hydrogen-fusing phase
- The Orion Nebula is a nearby stellar nursery we can observe



The Lives and Deaths of Stars

- Mass is destiny: a star's life story is set at birth
- Low-mass stars: red giant, planetary nebula, then white dwarf
- High-mass stars: core-collapse supernova, leaving a neutron star or black hole
- Fusion forges elements up to iron; supernovae create the rest



Stellar fusion builds elements **up to iron**.

Supernovae **create the rest** of the elements in the universe.

We Are Stardust

- Every atom in our bodies was forged inside a star.
- Carbon, oxygen, and nitrogen originated in stellar cores.
- Supernova explosions scattered these elements across space.
- *"We are a way for the cosmos to know itself."* — Carl Sagan
- Studying the cosmos is a journey of self-discovery.



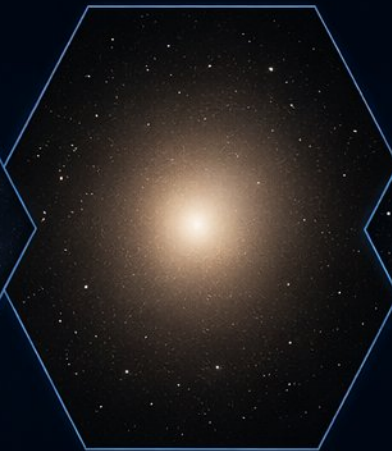
Galaxies: Cosmic Cities

- Massive systems of billions of stars, gas, dust, and dark matter
- Spiral, elliptical, and irregular are the three main galaxy types
- Andromeda is a spiral; the Large Magellanic Cloud is irregular
- Our Milky Way is a barred spiral; we live in the Orion Arm
- The Hubble Deep Field reveals countless galaxies in a tiny patch of sky



SPIRAL

Flat, rotating disks with spiral arms of stars and gas around a central bulge.



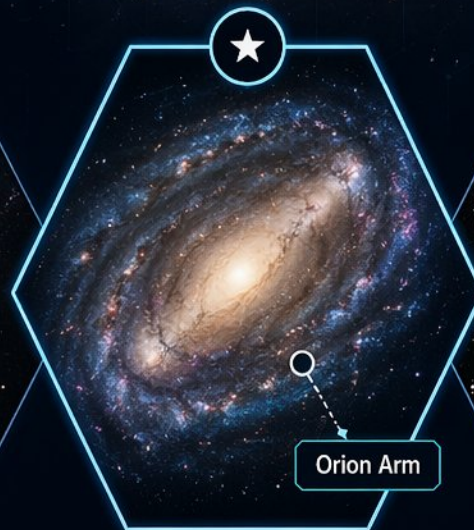
ELLIPTICAL

Spheroidal shapes with older stars and little gas or dust.



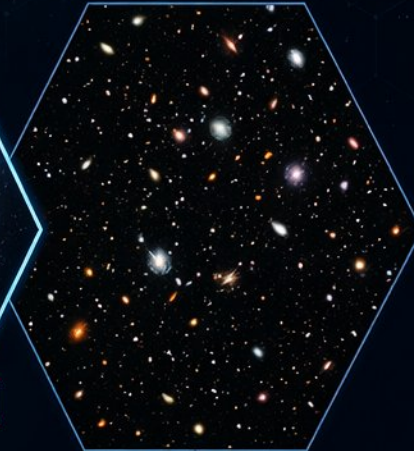
IRREGULAR

No defined shape; rich in gas and dust with active star formation.



MILKY WAY

A barred spiral galaxy. We live in the Orion Arm, about 26,000 light-years from the center.



HUBBLE DEEP FIELD

A tiny patch of sky revealing thousands of galaxies at vast distances.

The Expanding Universe



- Galaxies move away; farther ones recede faster



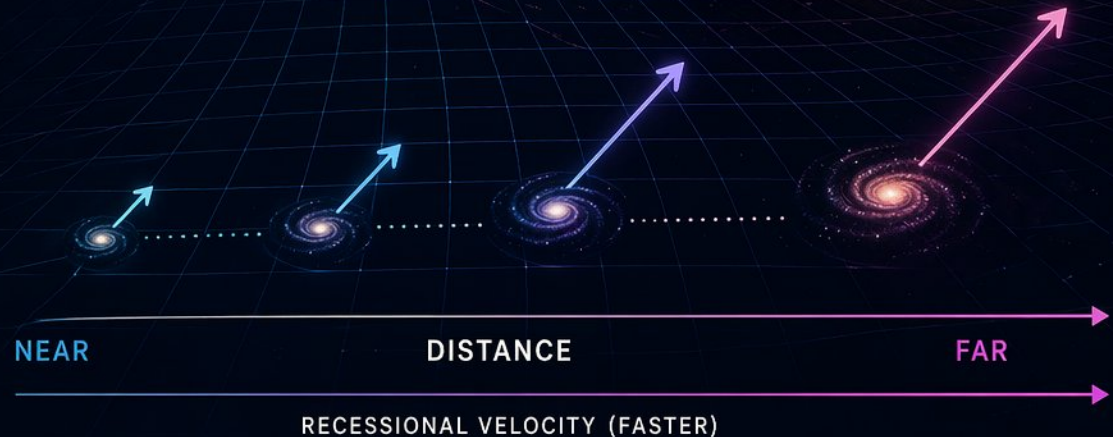
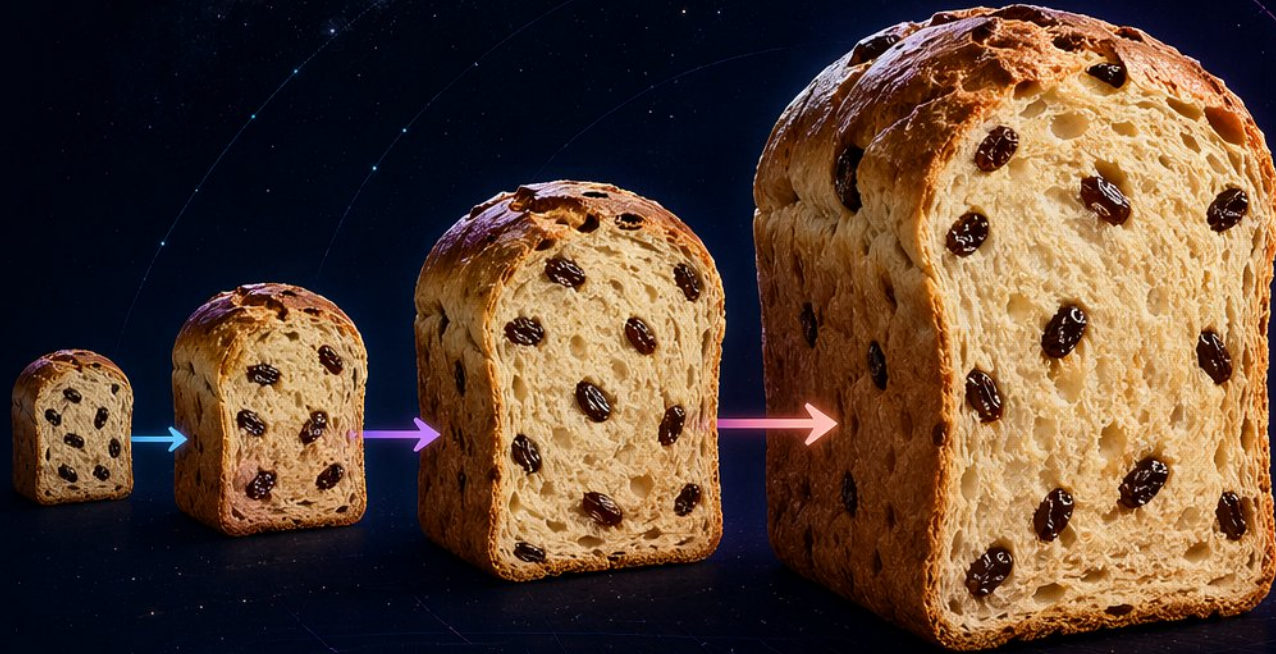
- Hubble's Law: velocity proportional to distance



- Space itself stretches, like rising raisin bread

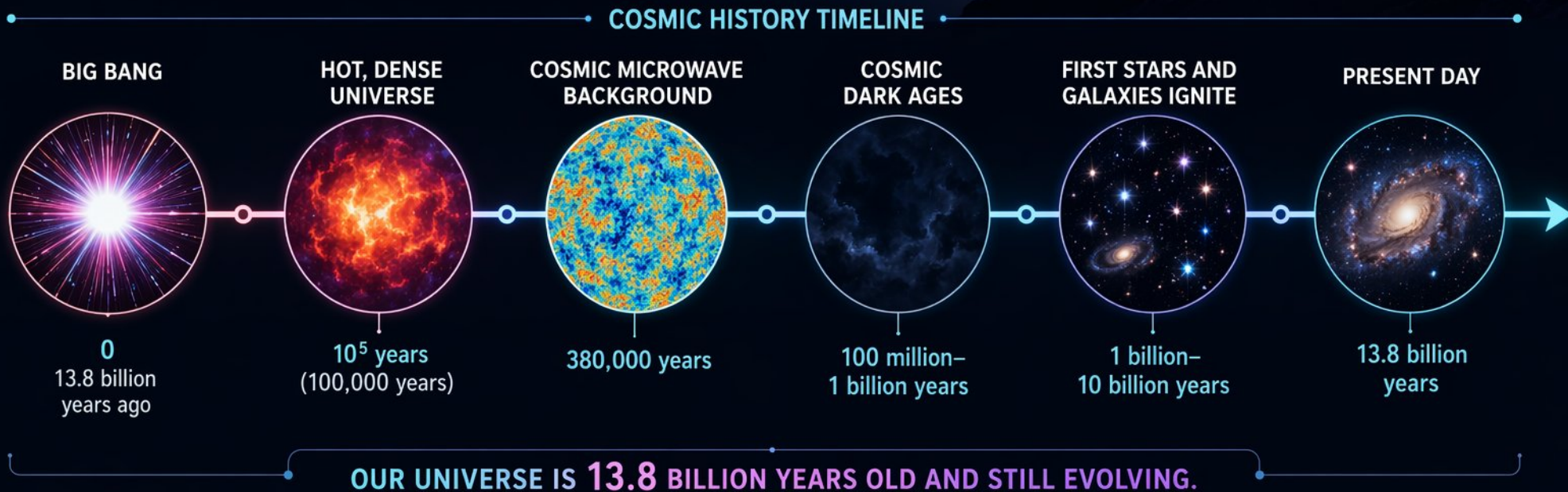


- Galaxies don't move through space—space expands between them



The Big Bang and Cosmic History

- The Big Bang was the expansion of space itself, not an explosion into space.
- From a hot, dense state, the universe cooled, forming the first atoms.
- The Cosmic Microwave Background is the faint afterglow of the Big Bang.
- After the Cosmic Dark Ages, the first stars and galaxies ignited.
- Our universe is 13.8 billion years old and still evolving.



The Exoplanet Revolution



- An exoplanet is a planet orbiting a star other than our Sun.
- Over 5,500 confirmed exoplanets, with discoveries surging since the 1990s.
- Transit method: detects tiny dips in starlight as a planet passes.
- Radial velocity: detects a star's wobble from an orbiting planet's gravity.
- Worlds range from scorching 'hot Jupiters' to rocky 'super-Earths' unlike our own.



HD 189733 b
HOT JUPITER

🌡️ ~1,000°C

🕒 2.2 days orbit



51 Pegasi b
GAS GIANT

🌌 0.05 AU

★ Orbiting Sun-like star



GJ 436 b
NEPTUNE-LIKE

🌌 0.03 AU

❄️ Likely icy atmosphere



Kepler-452 b
SUPER-EARTH

🌍 ~1.6× Earth size

★ In habitable zone



LHS 1140 b
ROCKY PLANET

🌍 ~1.3× Earth size

★ Orbiting red dwarf

The Habitable Zone and the Search for Life



- Habitable zone: the 'Goldilocks' region where liquid water can exist



- Liquid water is essential for life as we know it



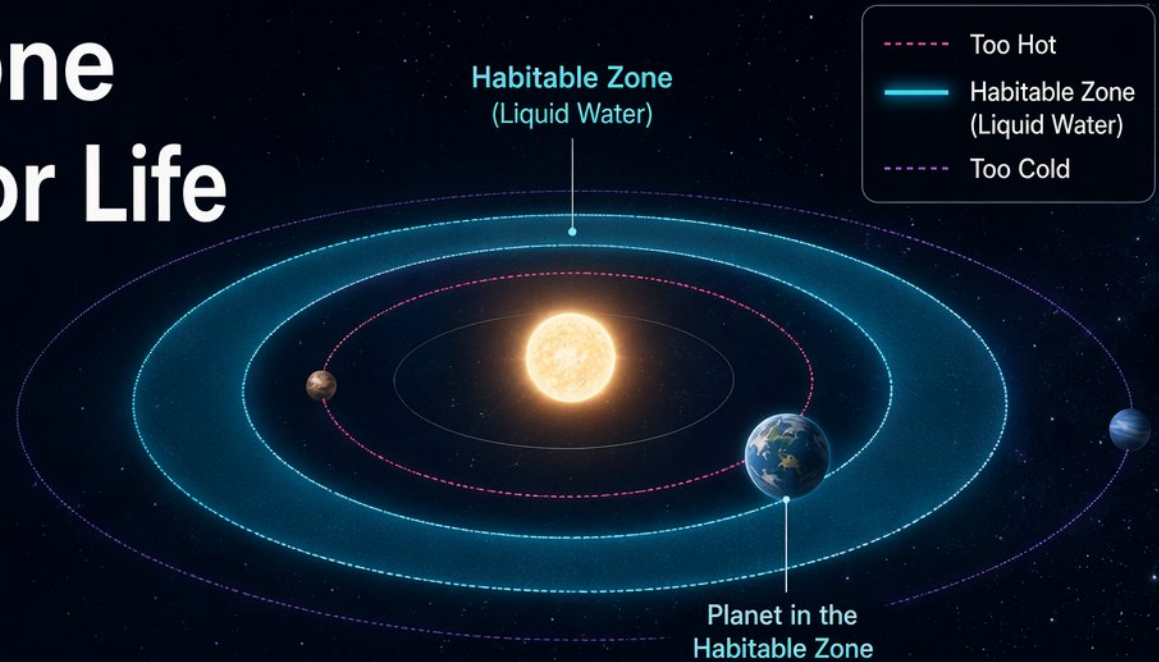
- JWST searches for biosignatures—chemical hints of life—in exoplanet atmospheres



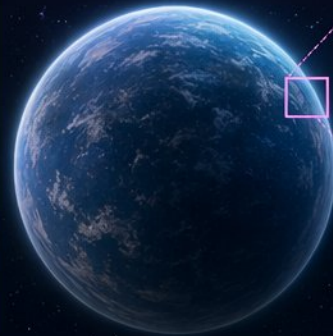
- K2-18b: a potential 'Hycean' world with tentative hints of dimethyl sulfide



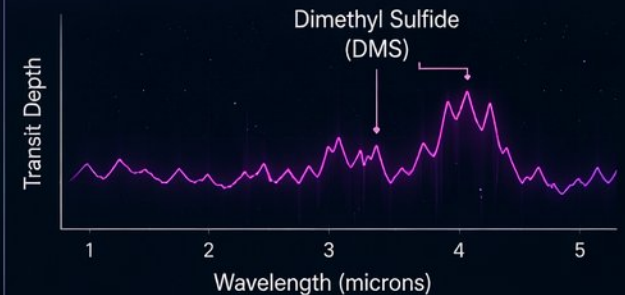
- Scientific debate continues; independent analyses dispute the signal's significance



K2-18b
Potential 'Hycean' World



Atmosphere (Transmission Spectrum)



Dimethyl Sulfide (DMS)
A potential biosignature gas

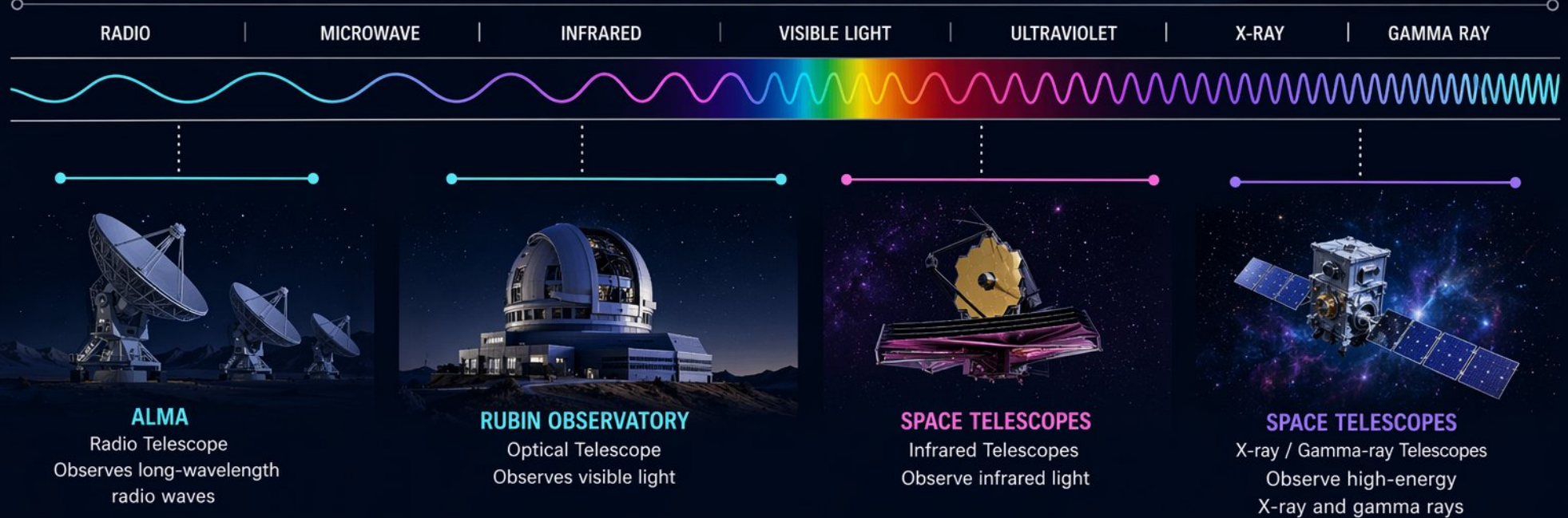


The search for life beyond Earth is a rigorous scientific endeavor, driven by data, tested by skepticism, and strengthened by independent verification.

How We Observe: Telescopes and Light



THE ELECTROMAGNETIC SPECTRUM

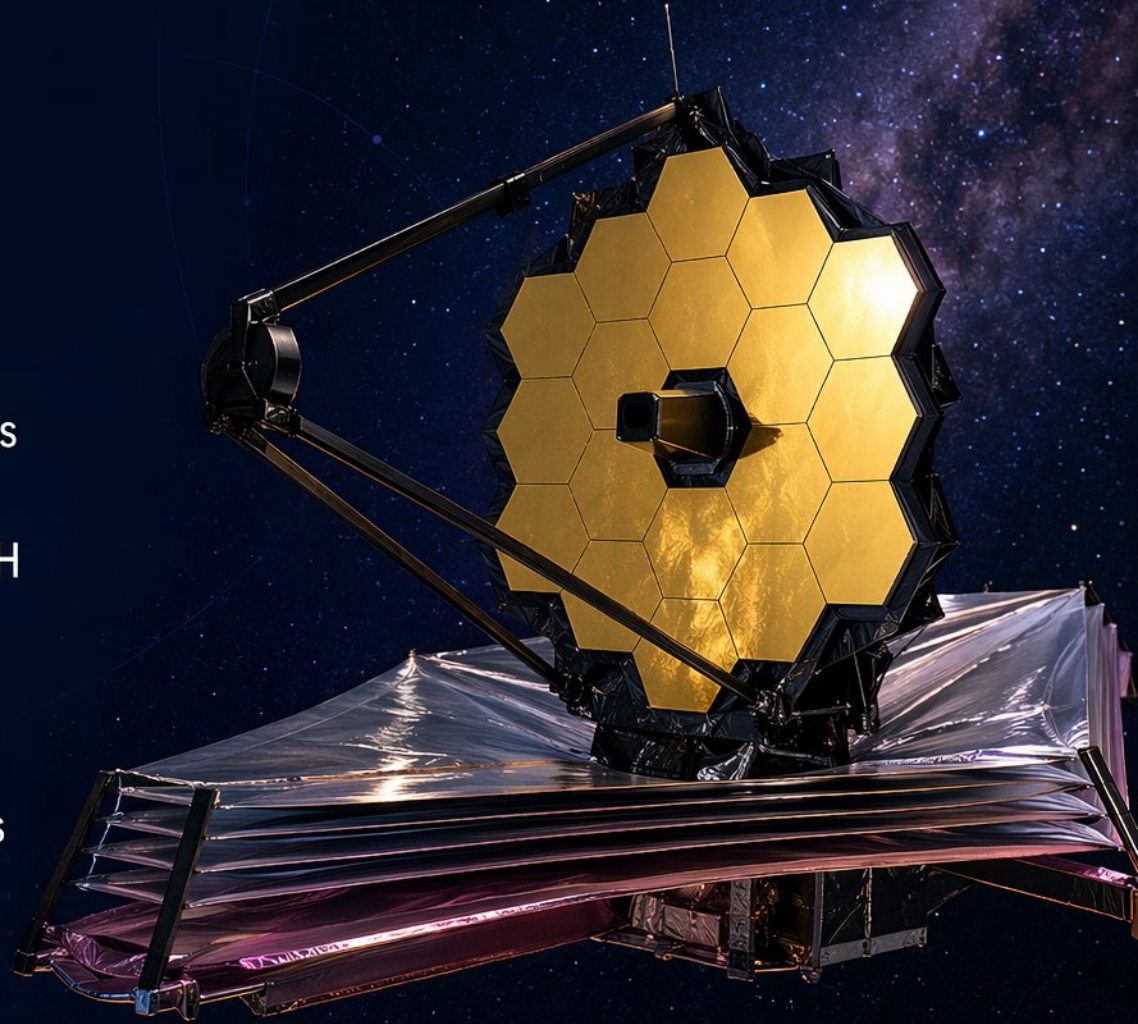


- Modern astronomy uses the full electromagnetic spectrum, from radio to gamma rays
- ALMA (radio) and Rubin Observatory (optical) are key ground-based facilities
- Rubin just began its 10-year Legacy Survey of Space and Time in June 2026
- World's largest digital camera (3,200 megapixels) creates a time-lapse movie of the southern sky
- Space telescopes avoid atmospheric distortion and observe blocked wavelengths (infrared, X-ray)



Flagship Space Observatories

- **Hubble Space Telescope:** deep-field images transformed cosmic view
- **JWST:** premier infrared observatory for first galaxies & exoplanet atmospheres
- **JWST** directly detected CO, H₂O, and OH on ultra-hot Jupiter WASP-18 b
- Future missions & ground-space synergy continue solving cosmic mysteries



Your July Night Sky

PREDAWN SKY VIEW

Looking Southeast
~1 hour before sunrise



- Predawn Moon-Mars-Saturn-Uranus lineup on July 11 and 12



- Mars-Uranus closest conjunction until 2053 on July 4



- Moon passes Saturn (July 7) and Venus (July 17)



- Milky Way core best viewed around July 14 New Moon



- Later in July: Saturn's rings appear unusually thin



JULY 2026

Predawn Sky Guide

Getting Started with Stargazing



- Start with unaided eyes: learn constellations and use a planisphere or app



- First instrument: 7x50 or 10x50 binoculars offer versatile, affordable viewing



- Escape light pollution: use online maps to find dark sky sites



- Resources: Stellarium, SkySafari, EarthSky, Sky & Telescope, local astronomy clubs



Recap and Your Cosmic Journey



- Tour from new solar system finds to distant exoplanets



- Star life cycles forge the elements we are made of



- Galaxies and expansion reveal our cosmic address



- Looking up connects us to the universe, and to ourselves



- Next: books, free courses, and citizen science projects



PersonWise.

PersonWise • AI digital-human course platform



Scan the code or click anywhere to watch this course live, with voice Q&A

personwise.ai/t/5a0157ef/public