Lecture 1: Looking Upward — Astronomy 101 with Dr. Brian Keating

🌌 Course Introduction

- **Goal:** Lay the foundation for a deep understanding of astronomy, the oldest and most accessible science
- **Instructor:** Dr. Brian Keating, cosmologist and lifelong lover of astronomy since age 12
- **Course Structure:** 8 lectures, covering everything from the solar system to the beginning of time

🌠 Definitions and Clarifications

- **Astronomy**: Greek origin "astron" (star) + "nomos" (law) = "star law" or "star culture"
- **Cosmology**: Study of the universe at its largest scales ("cosmos" meaning beauty, order)
- **Astrology ≠ Astronomy**: Astrology is not falsifiable, not scientific; astronomy is testable and falsifiable

🧠 Why Astronomy Matters

- Accessible to all: All you need are your eyes
- Interdisciplinary: Connects physics, philosophy, theology, and history
- Profound: Invites reflection on existence, time, and human purpose

👶 Personal Origin Story

- Age 12: First sight of Jupiter near the Moon sparked his obsession
- First job to buy a telescope: Venice Deli, Dobbs Ferry, NY

- First observations: Moon craters, moons of Jupiter — just like Galileo

📖 History & Heroes

👨‍🎓 Galileo Galilei

- First to use telescope for astronomy
- Saw craters on the Moon, moons orbiting Jupiter
- Used scientific method: observation, theory, repeat
- Wrong about some things (e.g., cause of tides)

🧠 Other Pioneers

- **Aristotle**: Earth is spherical (right), women have fewer teeth (wrong)
- **Eratosthenes**: Measured Earth's circumference with 12% accuracy
- **Copernicus**: Proposed heliocentric (Sun-centered) model
- **Kepler**: Laws of planetary motion, but made odd conjectures
- **Tycho Brahe**: Observed comets outside Earth's atmosphere, lost nose
- **Giordano Bruno**: Proposed infinite worlds, burned at stake
- **Caroline Herschel**: First paid female astronomer
- **Cecilia Payne-Gaposchkin**: Discovered stars are mostly hydrogen

🌌 Ancient Astronomy

- **Prehistoric Astronomers**:
- Tracked Moon, Sun, constellations
- Built monuments (e.g., Stonehenge) aligned with celestial events
- **Babylonians/Persians**:
- Developed constellations and zodiac
- Used astronomy for calendars, commerce, and religion
- **Egyptians & Hebrews**:
- Sun worship, lunar calendars
- Biblical references to cosmology ("In the beginning...")

🪐 Terms & Tools

- **Zodiac**: The 12 constellations the Sun passes through yearly
- **Planet**: From Greek "planētēs" = wanderer
- **Sextant, astrolabe, orrery**: Ancient tools to map the heavens

🧪 What Makes Astronomy Scientific?

- **Falsifiability**: The hallmark of science
- Example: Astrology isn't falsifiable — everything is always true
- **Experimentation Limits**:
- We cannot manipulate the cosmos, only observe it
- Main data sources: light (electromagnetic radiation), meteoritic material, gravitational waves & neutrinos

🔭 Tools of Observation

- **The Eye**: Only organ with brain tissue outside the skull
- **Telescopes**: From Galileo's time to the James Webb Space Telescope
- **Amateur Astronomers**: Still contribute to major discoveries

🌍 Shape of the Earth

- Aristotle & eclipses: Earth's shadow proves it's round
- Eratosthenes: Measured Earth's circumference using shadows in Alexandria and Syene
- Earth is an **oblate spheroid**, not a perfect sphere

⏳ Importance of Timekeeping

- Accurate calendars crucial for planting, religious observance
- Timekeeping enabled trade and navigation

- **Greenwich**: Prime Meridian origin of universal time

💫 Renaissance Shift

- **Copernicus**: Proposed heliocentric model (Sun at center)
- **Retrograde Motion**:
- Explained more simply with heliocentrism
- Planets appear to reverse direction due to Earth's relative motion
- **Ptolemaic System**: Earth-centered; complex epicycles

🛰️ Space Exploration

- **Moon landing**: 1969
- **Mars & Venus probes**: Confirm planetary details
- **Olympus Mons** (Mars): Tallest volcano in solar system
- **Venera Probes** (Venus): Melted in 15 minutes due to heat
- **Kepler Telescope**: Found over 2,600 exoplanets

💡 Final Thoughts

- **Science is iterative**: We are always refining ideas
- **Humility is key**: Great scientists were often wrong
- **Astronomy is for everyone**: Inspires awe, wonder, and discovery

“You can’t do astronomy if you’re afraid to be embarrassed by later discoveries.” — Dr. Brian Keating