WORLD AND PHYSICAL GEOGRAPHY

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1. Universe

Constellations and Asterisms: Basic identification and significance

- Constellation: An apparent pattern of stars in the night sky as viewed from Earth.
- Stars within a constellation are not physically close or equidistant from Earth; their perceived pattern is a projection effect.
- The International Astronomical Union (IAU) officially recognizes 88 constellations, each with defined boundaries covering the entire celestial sphere.
- Asterism: A prominent, recognizable pattern of stars that is not one of the 88 official IAU constellations.
- Asterisms can be part of a larger constellation (e.g., Big Dipper within Ursa Major) or span across multiple constellations (e.g., Summer Triangle).
- Significance: Historically used for navigation (e.g., Polaris), timekeeping/calendars (tracking seasons), and as the basis for cultural myths and stories. In modern astronomy, they aid in sky mapping and locating celestial objects.

Galaxies: Types, characteristics, and the Milky Way

- Galaxy: A massive, gravitationally bound system consisting of stars, stellar remnants, interstellar gas and dust, and dark matter.
- Types of Galaxies:
    - Spiral Galaxies:
        - Disk-shaped with a central bulge and spiral arms.
        - Contain significant amounts of gas and dust, active star formation (young, blue stars).
        - Subtypes: Normal Spiral (Sa, Sb, Sc) and Barred Spiral (SBa, SBb, SBc).
        - Example: Milky Way (Barred Spiral), Andromeda Galaxy (Spiral).
    - Elliptical Galaxies:
        - Range from nearly spherical to highly flattened ellipsoids.
        - Contain little gas and dust, primarily older, redder stars.
        - Vary widely in size; most common type of galaxy in the universe.
    - Irregular Galaxies:
        - Lack a distinct regular shape (neither spiral nor elliptical).
        - Often results of galactic interactions or mergers.
        - Rich in gas and dust, with vigorous star formation.
- Milky Way Galaxy:
    - Type: Barred Spiral Galaxy.
    - Components: Contains our Sun and Solar System, 100-400 billion stars, vast interstellar gas, dust, and dark matter.
    - Size: Approximately 100,000 to 120,000 light-years in diameter and about 1,000 light-years thick.
    - Sun's Location: Located in one of the minor spiral arms (Orion Arm/Spur), roughly two-thirds of the way from the galactic center (about 26,000 light-years away).
    - Rotation: The Sun orbits the galactic center once every 225-250 million years (a "cosmic year").
    - Neighbors:
        - Part of the "Local Group" of galaxies, which includes the Andromeda Galaxy (M31), Triangulum Galaxy (M33), and ~50 smaller dwarf galaxies.
        - Andromeda Galaxy is the closest large galaxy to the Milky Way, also a spiral.
    - Future: The Milky Way and Andromeda Galaxy are on a collision course and are expected to merge in about 4.5 billion years to form a larger elliptical galaxy (sometimes called "Milkomeda").

Origin and Evolution of the Universe (Big Bang Theory)

- The Big Bang theory, also known as the Expanding Universe Hypothesis, is the most accepted scientific model explaining the origin and evolution of the Universe.
- Proposed by Georges Lemaître in 1927.
- Edwin Hubble provided observational evidence for the expanding universe (redshift of galaxies) in 1929.
- Postulates that the Universe originated approximately 13.7 billion years ago from an extremely hot, dense point (singularity).
- The "big bang" was not an explosion in space, but an expansion of space itself.
- Key stages involve initial rapid expansion (inflation), cooling, formation of fundamental particles, then atoms (primarily hydrogen and helium).
- Over vast periods, matter clumped together due to gravity to form stars, galaxies, and galaxy clusters.
- Major evidence supporting the theory includes:
    - The observed expansion of the Universe (Hubble's Law).
    - Cosmic Microwave Background (CMB) radiation – residual heat from the early universe.
    - The abundance of light elements (hydrogen and helium) in the Universe.

Stars: Stellar evolution, life cycle, and different types of stars

- Stars originate from nebulae, which are giant clouds primarily composed of Hydrogen (H) and Helium (He) gas, along with dust.
- The process of star formation begins with the gravitational collapse of these gas and dust clouds, forming a protostar.
- A star enters its main-sequence phase when nuclear fusion of Hydrogen into Helium begins in its core, providing outward pressure that balances gravity.
- The life cycle and ultimate fate of a star depend primarily on its initial mass:
    - Low to Medium-Mass Stars (like our Sun): Main Sequence → Red Giant → Planetary Nebula → White Dwarf → Black Dwarf.
    - High-Mass Stars: Main Sequence → Red Supergiant → Supernova → Neutron Star or Black Hole (depending on the remnant core's mass).
- Stars are broadly classified by their temperature and color (from hottest to coolest): O (blue), B, A, F, G (yellow, like the Sun), K, M (red).
- Proxima Centauri is the nearest known star to Earth, excluding the Sun, and is part of the Alpha Centauri star system.

2. General Concept

Basic Principles of Weather and Climate

- Disasters & Characteristics:
    - Volcanic eruption: Release of magma.
    - Cyclone: Characterized by violent winds.
    - Tsunami: Triggered by submarine earthquakes or landslides.
    - Drought: Can lead to desertification.
- Thermal Properties & Climate:
    - Water has a higher specific heat capacity than land.
    - This leads to oceans heating up and cooling down slower than land.
    - Result: Continents experience greater temperature contrasts (larger annual/seasonal range) compared to oceans.
- Meteorological Instruments:
    - Anemometer: Measures wind velocity.
    - Barograph: Records atmospheric pressure.
    - Hygrometer: Measures humidity.
    - Seismograph: Measures earthquake activity.
- Rain Gauges:
    - Self-recording types: Tipping bucket, Float type, Weighing type.
    - Non-self-recording type: Symon's rain gauge (standard).