HOYLE–NARLIKAR THEORY OF GRAVITY – SCIENCE & TECHNOLOGY

NEWS: Eminent Indian astrophysicist, science communicator, and Padma Vibhushan awardee Jayant Narlikar passed away recently at the age of 87.

WHAT'S IN THE NEWS?

About Astrophysicist Jayant Narlikar

1. Scientific Legacy:
    - Dr. Jayant Vishnu Narlikar is a renowned Indian astrophysicist best known for co-developing the Hoyle–Narlikar Theory of Gravity in 1964, along with eminent English astronomer Fred Hoyle.
    - His work offers an alternative approach to gravity and cosmology, challenging the prevailing Big Bang paradigm.
2. Institution Builder:
    - Dr. Narlikar played a foundational role in Indian astrophysics by establishing the Inter-University Centre for Astronomy and Astrophysics (IUCAA) in Pune.
    - IUCAA has become a premier research institute for astrophysics and cosmology in India, fostering inter-university collaboration and public engagement.
3. Literary Contributions:
    - He is also known for his science-fiction writing. His notable story "Dhoomaketu" (The Comet) explores cosmic themes in fictional settings.
    - His autobiography, titled *"Chaar Nagarantale Maze Vishwa"* (*My Tale of Four Cities*), reflects his personal and professional journey and was awarded the Sahitya Akademi Prize, showcasing his literary depth.
4. Awards and Recognition:
    - Padma Bhushan (1965) and Padma Vibhushan (2004), among India's highest civilian honours.

- UNESCO Kalinga Prize (1996) for his work in science communication and public engagement.
- Prix Jules Janssen (2004), awarded by the French Astronomical Society for his outstanding contributions to astronomy.
- Govind Swarup Lifetime Achievement Award for his lifetime dedication to scientific research and public science education.

The Hoyle–Narlikar Theory of Gravity

1. Alternative to Einstein's General Relativity:
    - Proposed as an alternative theory to Einstein's General Theory of Relativity, the Hoyle–Narlikar theory aims to integrate Mach's Principle into gravitational theory.
    - It blends principles from electromagnetism and cosmology to describe gravity in a new light.
2. Mach's Principle – Core Philosophical Basis:
    - According to Mach's Principle, the inertia of any object is not intrinsic but arises from its interaction with the mass of all other objects in the universe.
    - This theory suggests that inertia and mass are not fixed properties but are determined by the entire mass distribution in the universe.
3. Key Components of the Theory:
    - Steady State Universe:
        - Opposing the Big Bang theory, it postulates that the universe is eternally existing, with no beginning or end, and is uniform in density over time.
    - Continuous Matter Creation:
        - While accepting an expanding universe, the theory suggests that new hydrogen atoms are continuously created to maintain constant density.
    - Creation Field (C-field):

        - Introduces a hypothetical negative-energy field responsible for spontaneous matter creation.
        - When the C-field reaches sufficient intensity at any point in space, a new hydrogen atom forms.
    - Variable Gravitational Constant (G):
        - Unlike General Relativity, which treats G as a universal constant, the Hoyle–Narlikar theory proposes that G varies with the average matter density in the universe.

Applications of the Hoyle–Narlikar Theory

1. Black Holes and White Holes:
    - The theory allows exploration of exotic spacetime features such as zero-mass surfaces, which provide a framework to study black hole and white hole formation.
2. Anomalous Redshifts in Quasars:
    - It has been suggested that unusual redshifts seen in some quasars and galaxies might be explained by local shifts in zero-mass surfaces predicted by the theory.
3. Modified Gravity Models:
    - Contemporary researchers have used its framework to model dark energy and the accelerated expansion of the universe, by modifying gravitational dynamics and matter properties.

Challenges Faced by the Theory

1. Empirical Limitations:
    - The discovery of Cosmic Microwave Background (CMB) radiation in 1965 provided strong evidence in support of the Big Bang Theory, posing a major challenge to the steady-state assumptions of the Hoyle–Narlikar model.
2. Lack of Direct Observational Support:

- While conceptually elegant, the theory has struggled to gain widespread observational validation, unlike Einstein's General Relativity, which has repeatedly been confirmed by empirical data.

Cosmic Microwave Background (CMB) Radiation

1. Definition:
    - The CMB radiation is the faint thermal radiation left over from the early universe, often described as the echo of the Big Bang.
2. Significance:
    - It serves as one of the most compelling evidences for the Big Bang Theory, reinforcing the idea that the universe originated from a hot, dense singularity approximately 13.8 billion years ago.

Comparison Table: Einstein's General Relativity vs. Hoyle–Narlikar Theory

Feature	Einstein's General Relativity	Hoyle–Narlikar Theory of Gravity
Core Idea	Gravity results from the curvature of spacetime due to mass	Gravity incorporates Mach's Principle, emphasizing interaction with all matter
Inertia Explanation	Does not explicitly explain origin of inertia	Inertia arises from interaction with all mass in the universe
Gravitational Constant (G)	Treated as a fixed universal constant	Treated as variable, dependent on average density of matter
Evidence and Validation	Supported by empirical tests: gravitational lensing, Mercury's orbit, gravitational waves	Has limited observational support; faced criticism post-CMB discovery
View on Universe	Supports a Big Bang beginning and evolving universe	Proposes a steady-state, eternal, and self-renewing universe

Feature	Einstein’s General Relativity	Hoyle–Narlikar Theory of Gravity
Matter Creation	No continuous matter creation post-Big Bang	Introduces a C-field to enable continuous hydrogen atom creation

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