

Dr. Perry Phillips, Herman Lecture Series, Part 3, 2022

Big Bang, the beginning of the universe, dark matter, multiverses, and other difficulties

Author: Perry Phillips

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Abstract

This podcast explores a lecture by Perry Phillips on modern cosmological theories and the invisible forces that govern our universe. It details how scientists discovered dark matter and dark energy through anomalous galactic rotations and the accelerating expansion of space. The discussion addresses the critical horizon and flatness problems, explaining how Alan Guth's theory of cosmic inflation resolves these paradoxes. Finally, it examines the concept of a multiverse, string theory, and the philosophical implications of mathematical laws existing prior to the universe itself.

Outline

I. Introduction to the Cosmic Mystery

- **A.** The expansion of the universe is accelerating, which directly contradicts basic gravitational expectations.
- **B.** Discussion is based on Perry Phillips's lecture: "Big Bang, the beginning of the universe part three, dark matter, multiverses, and other difficulties".

II. The Evidence for Dark Matter (The Invisible Glue)

- **A.** Early measurements of galaxy clusters showed a massive discrepancy between visible mass and gravitational velocities, indicating that clusters had far too little visible gravity to hold themselves together.

- **B.** Vera Rubin's groundbreaking 1970s research on spiral galaxies, such as Andromeda, solidified this mystery:
 - **1.** Stars on outer edges rotate just as fast as those near the dense galactic core, defying standard Newtonian orbital predictions.
 - **2.** This implies galaxies are kept in formation by "dark matter," an invisible, non-interactive substance acting as an "invisible seat belt".

III. The Recipe of the Universe and the Expansion Crisis

- **A.** Calculating cosmic ingredients using the oldest light in the sky: the Cosmic Microwave Background Radiation (CMBR):
 - **1.** The CMBR represents the fading afterglow of the Big Bang, frozen when the universe cooled after 380,000 years of plasma opacity.
 - **2.** Mapping temperature fluctuations (anisotropies or "splotches") reveals a peak diameter of one degree in the sky.
 - **3.** Variables are adjusted mathematically to match this peak: dark matter, dark energy, baryonic (ordinary) matter, and the Hubble constant (expansion rate).
- **B.** The Hubble Constant Tension and its Resolution:
 - **1.** A major "three-sigma" discrepancy (99.7% confidence) existed between CMBR data and traditional local measurements of expansion.
 - **2.** Wendy Freedman resolved this crisis using the "red giant branch" as a highly accurate cosmic yardstick.
 - **3.** The red giant branch relies on the highly predictable peak brightness of a helium flash in dying stars.
 - **4.** Reconciling independent CMBR and stellar measurements to within a 5% agreement is considered a monumental scientific triumph.

IV. Two Major Paradoxes of the Big Bang Theory

- **A. The Horizon Problem:** Opposite regions of the universe, separated by 28 billion light-years, are identical in temperature and structure despite never having been in light-travel contact.

- **B. The Flatness Problem:** Today's universe is geometrically flat within a 4% margin, which mathematically requires a staggering flatness accuracy of one part in at seconds after the Big Bang to prevent immediate collapse or dispersal.

V. Cosmic Inflation: The Ultimate Solution

- **A.** Proposed by physicist Alan Guth in the 1980s while investigating the missing magnetic monopole problem.
- **B. Mechanics of Inflation:** A sub-proton-sized seed underwent extreme repulsive gravity, doubling 100 times to marble-size in a fraction of a millisecond (to seconds).
- **C.** How inflation resolves three primary cosmological crises simultaneously:
 - **1. Monopoles:** Stretched space out so vastly that magnetic monopoles are diluted and virtually impossible to find.
 - **2. Horizon:** The entire observable universe was packed tightly inside a tiny seed, allowing temperatures to equalize before inflation blew it apart.
 - **3. Relativity:** Space itself stretched faster than light, which does not violate Einstein's speed limit for physical objects moving *through* space.
 - **4. Flatness:** Any early chaotic geometric curvature was stretched out perfectly flat, like a balloon inflated to the size of the Earth.
 - **5. Quantum fluctuations:** Heisenberg's uncertainty principle's microscopic quantum wrinkles were frozen and magnified into cosmic proportions, forming galaxies and stars.

VI. The Multiverse, String Theory, and the Anthropic Principle

- **A.** The mechanics of inflation suggest that repulsive gravity on microscopic seeds could occur repeatedly, resulting in an infinite multiverse.
- **B. The Dark Energy Crisis:** Theoretical calculations of virtual photon energy are times larger than observed, which is considered the most embarrassing prediction in physics.
- **C. String Theory Framework:** Microscopic vibrating strings across extra dimensions suggest a landscape of possible vacuum states.

- **D. The Anthropic Principle (Principle of Mediocrity):** We live in a highly improbable, finely tuned universe because it is the only lucky seed where stars, carbon, and human life can exist.

VII. Philosophical and Theological Boundaries of Science

- **A.** Quantum tunneling models imply the universe spontaneously emerged from absolute nothingness, governed by preexisting physical laws.
- **B. Philosophical awe:** Reaching the limits of knowledge where science, math, and theology intersect, as illustrated by Robert Jastrow's metaphor of scientists scaling the mountain of ignorance only to find theologians waiting at the peak.