INTERNATIONAL MULTIDISCIPLINARY JOURNAL FOR RESEARCH & DEVELOPMENT
SJIF 2019: 5.222 2020: 5.552 2021: 5.637 2022:5.479 2023:6.563 2024: 7,805
eISSN :2394-6334 https://www.ijmrd.in/index.php/imjrd Volume 12, issue 07 (2025)

ANTIMATTER IN THE UNIVERSE: WHY AREN'T WE MADE OF ANTIMATTER?

Muzafarova Sevinch Muhammadovna
Student of the Faculty of Physics-Mathematics and Information Technologies,
Bukhara State University

Abstract: According to the Big Bang theory, matter and antimatter must have been created in equal amounts during the earliest moments of the universe. However, the observable universe today consists almost entirely of ordinary matter, while traces of antimatter are extremely rare. This article explores the physical nature of antimatter, scientific perspectives on its presence in the universe, and modern hypotheses regarding the causes of matter-antimatter asymmetry.

Keywords: antimatter, Big Bang, asymmetry, CP violation, matter, annihilation, universe

Every particle — for instance, an electron — has a corresponding "anti-particle." For the electron, this is the **positron**, which has a positive charge; for the proton, it's the **antiproton**, with a negative charge. According to the laws of physics, matter and antimatter should have been produced in equal amounts during the Big Bang. Yet, modern observations show that the universe is composed almost entirely of ordinary matter. Antimatter is exceedingly scarce.

This raises the critical question: If matter and antimatter were created equally, **where did the antimatter go?** Or put differently: **Why are we made of matter and not antimatter?**

In theory, matter and antimatter obey the same physical laws and should have been formed symmetrically, eventually annihilating one another. When a matter particle collides with its corresponding antimatter particle, they annihilate each other, releasing large amounts of energy — a process called **annihilation**. Despite this, the galaxies, stars, planets, and even the human body are composed of ordinary matter. No stars or galaxies composed of antimatter have yet been discovered.

This contradiction remains one of the most fundamental mysteries in cosmology and particle physics. It is known as **baryon asymmetry** — the question of why matter dominates over antimatter, and where the antimatter has gone. Modern research, including observations of cosmic background radiation and high-energy particle experiments (such as those at CERN), is working to uncover the answer to this puzzle.

This article discusses the nature of antimatter, various hypotheses concerning the asymmetry between matter and antimatter, and their implications for our understanding of the universe.

The Nature of Antimatter

Antimatter is similar to ordinary matter but with opposite electric charges:
- Electron ↔ Positron
- Proton ↔ Antiproton
- Neutron ↔ Antineutron

When matter and antimatter collide, they annihilate each other in a process known as **annihilation**, producing pure energy (typically gamma rays).

In physics, this phenomenon is referred to as **"baryon asymmetry"** — that is, why is there more matter than antimatter in the universe?

According to the Big Bang theory, during the first moments of the universe, for every 10 billion antiparticles, there was 1 excess matter particle. After mutual annihilation of particles and antiparticles, only that tiny surplus of matter remained — which eventually formed everything we observe in the universe today.

But how did such a small imbalance arise in the first place? The exact cause remains unknown, yet several plausible explanations have been proposed.

Physicists suggest a few main hypotheses:

1. CP Violation. In theory, matter and antimatter should behave symmetrically. However, certain particles — such as kaons and B-mesons — have been observed to violate **Charge (C) and Parity (P) symmetry**. This phenomenon, known as **CP violation**, may have contributed to the dominance of matter over antimatter.

2. Leptogenesis and Baryogenesis. After the Big Bang, leptons (like electrons and neutrinos) and baryons (like protons and neutrons) may have formed in unequal quantities through processes known as **leptogenesis** and **baryogenesis**. These mechanisms could have favored matter over antimatter, contributing to the imbalance.

3. Absence of Antimatter Galaxies. If there were antimatter galaxies in the universe, we would expect intense gamma radiation at the boundaries between matter and antimatter regions due to annihilation. However, no such radiation has been observed, suggesting that antimatter is either extremely rare or completely absent on cosmic scales.

Despite decades of study, traces of antimatter have not been found in the universe. This mystery remains one of the most profound questions in modern physics: **Why, in a universe where matter and antimatter should have been created equally, is matter so dominant?**

Understanding the answer to this question is not only crucial for fundamental physics but also for understanding the origin of the universe — and even our own existence.

The antimatter problem remains one of the most puzzling questions in modern cosmology. Theoretically, matter and antimatter should have been created in equal amounts during the Big Bang, but today we observe a universe composed almost entirely of matter. While the reasons for this asymmetry remain incomplete, several key mechanisms — such as **CP violation**, **baryogenesis**, and **leptogenesis** — are currently the leading explanations under investigation.

Ongoing research in particle physics and cosmology — particularly at major facilities like **CERN**, **LHCb**, and other high-energy experiments — is crucial in deepening our understanding of this cosmic asymmetry. These efforts may not only solve the mystery of antimatter but also transform our perspective on the very origins of the universe.

References:

INTERNATIONAL MULTIDISCIPLINARY JOURNAL FOR RESEARCH & DEVELOPMENT
SJIF 2019: 5.222 2020: 5.552 2021: 5.637 2022:5.479 2023:6.563 2024: 7,805
eISSN :2394-6334 https://www.ijmrd.in/index.php/imjrd Volume 12, issue 07 (2025)

1. Sakharov, A.D. (1967). Violation of CP Invariance, C asymmetry, and baryon asymmetry of the universe. JETP Letters.
2. Riotto, A., & Trodden, M. (1999). Recent progress in baryogenesis. Annual Review of Nuclear and Particle Science.
3. CERN. (2022). What happened to the antimatter? https://home.cern/science/physics/antimatter
4. Carroll, S. (2010). From Eternity to Here: The Quest for the Ultimate Theory of Time. Dutton.
5. Canetti, L., Drewes, M., & Shaposhnikov, M. (2012). Matter and antimatter in the universe. New Journal of Physics, 14(9), 095012.
6. Peskin, M.E., & Schroeder, D.V. (1995). An Introduction to Quantum Field Theory. Addison-Wesley.