STUDY OF THE UNIVERSE AND DESIGN OF ITS MODEL USING HTML, JAVASCRIPT AND CSS

A Project Report

Submitted to

Department of STEM

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Sifal, Kathmandu, Nepal

Submitted by

Subigya Raj Kharel

Roll No: 29065

Date: 07/12/2026

Acknowledgment

I would like to express my sincere appreciation to the STEM Department for providing me with the opportunity to undertake this independent project entitled "Study of the Universe and Design of Its Model Using HTML, JavaScript, and CSS." This project has significantly enhanced my understanding of astronomy, the hierarchical structure of the universe, and the application of modern web technologies in creating interactive scientific visualizations. It has also enabled me to bridge the gap between theoretical scientific concepts and their practical implementation through an immersive educational model.

I am especially grateful to my supervisor, Mr. Ankur Raj Upadhayay from the Science Department, for his continuous support, valuable guidance, and constructive suggestions throughout the course of this project. His encouragement, insightful feedback, and mentorship played a vital role in the successful completion of this work.

Name: Subigya Raj Kharel
Roll No: 29065
Date: 07/12/2026

Letter of Approval

This is to certify that this project prepared by **SUBIGYA RAJ KHAREL** entitled **STUDY OF THE UNIVERSE AND DESIGN OF ITS MODEL USING HTML, JAVASCRIPT AND CSS** has been well studied. In our opinion, it is satisfactory in the scope and quality as a project for the required academic level.

Evaluation Committee

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Ankur Raj Upadhyay

Supervisor

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Ganesh Tamang

External Examiner

Date: 07/12/2026

ABSTRACT

Understanding the immense scale of the universe is one of the greatest challenges in astronomy education. While textbooks and static diagrams provide valuable information, they often fail to effectively convey the enormous differences in size and distance between astronomical structures. This project, **"Study of the Universe and Design of Its Model Using HTML, JavaScript, and CSS"** was undertaken to address this challenge by developing an interactive three-dimensional web-based visualization that allows users to explore the universe from a human scale to the observable universe through a continuous and immersive experience.

The project involved extensive research on the hierarchical structure of the universe, including the Earth–Moon system, the Solar System, the Oort Cloud, the Milky Way Galaxy, the Local Group, the Virgo Cluster, the Laniakea Supercluster, the Cosmic Web, and the observable universe. Scientifically accepted measurements and data from reliable astronomical sources were collected and incorporated into the visualization using a logarithmic scaling approach. The application was developed using HTML, CSS, JavaScript, and the Three.js graphics library to create an interactive educational model featuring three-dimensional representations, informative panels, and smooth scale transitions.

The completed model successfully demonstrates the vastness of the universe in an engaging and scientifically accurate manner while making complex astronomical concepts more accessible to learners. By combining scientific research with modern web technologies, this project highlights the effectiveness of interactive visualization as a tool for science education and encourages greater curiosity and understanding of the universe.

Keywords: Universe, Astronomy, Scientific Visualization, Three.js, Interactive Web Application, Cosmic Scale, STEM Education.

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CHAPTER I

1 Introduction

The universe includes all matter, energy, space, and time, together with the countless structures formed within it. These structures exist across an extraordinary range of scales, beginning with planets and planetary systems and extending to stars, galaxies, galaxy clusters, superclusters, the cosmic web, and the observable universe. Planetary measurements alone already involve vast differences in size and distance, while the distribution of matter on the largest scales forms complex networks of clusters, filaments, walls, and voids [1, 2]. Modern cosmological observations have further improved scientific understanding of the age, expansion, and large-scale properties of the universe [3].

Although these structures can be described numerically, their true scale is difficult to imagine. The difference between the size of a person, a planet, a solar system, a galaxy, and the observable universe extends across many orders of magnitude. Traditional textbooks and static diagrams are useful for explaining individual astronomical objects, but they often compress distances or enlarge objects so that they can fit on a page. As a result, such illustrations may not fully communicate the immense emptiness of space or the hierarchical relationship between different cosmic structures.

This project was designed to address this difficulty through an interactive three-dimensional web-based model of the universe. The model begins with familiar local references, including a human figure named Ram, Dharahara, and Kathmandu, before progressing outward through Earth, the Earth–Moon system, the Solar System, the Oort Cloud, nearby stars, the Orion Arm, the Milky Way, the Local Group, the Virgo Cluster, the Laniakea Supercluster, the cosmic web, and, finally, the observable universe. This sequence allows the user to move gradually from everyday human experience to increasingly larger astronomical structures.

Because the represented objects differ enormously in size, a direct linear scale would be impractical. Therefore, the model uses a logarithmic progression to compress extreme differences while preserving the correct order and relative hierarchy of the selected scales. Three-dimensional models, scale navigation, scientific information panels, and perspective facts are combined to create an immersive learning experience. The project therefore aims to demonstrate how interactive scientific visualization can make the vast structure of the universe easier to understand, compare, and explore.

1.1 The Scale of the Universe

The universe is organized as a hierarchy of structures that differ enormously in both size and distance. At the smallest scale are humans and man-made structures, followed by cities, planets, planetary systems, stars, galaxies, galaxy groups, galaxy clusters, superclusters, and ultimately the observable universe. Each successive level is many times larger than the one before it, creating differences that span more than twenty-six orders of magnitude. Such an immense range makes the universe one of the most challenging scientific systems to comprehend through everyday experience [1, 2, 3].

Astronomers use different units of measurement to describe these vast distances. Within the Solar System, distances are commonly expressed in astronomical units (AU), while distances between stars and galaxies are measured in light-years. As observations extend to even larger scales, measurements are often expressed in millions or billions of light-years. These units provide a practical means of describing astronomical distances, but numerical values alone often fail to convey the true scale of the universe [1, 3].

The universe also exhibits a clear hierarchical organization. Planets orbit stars, stars form galaxies, galaxies are bound together into groups and clusters, and these clusters are connected through an immense network of filaments known as the cosmic web. The observable universe encompasses all of these structures that can currently be observed from Earth, representing only the portion of the universe whose light has had sufficient time to reach us since the beginning of cosmic expansion [2, 3].

Because of these extraordinary differences in scale, conventional diagrams cannot accurately represent every astronomical structure using a single linear scale. If planets were drawn at their true relative sizes, their distances would become too large to fit on a page, while galaxies and larger structures would be impossible to display simultaneously. Consequently, scientific visualization techniques such as logarithmic scaling are frequently employed to compress these differences while preserving the correct hierarchical relationships between objects. This approach enables learners to better appreciate the true vastness and organization of the universe without compromising scientific understanding.

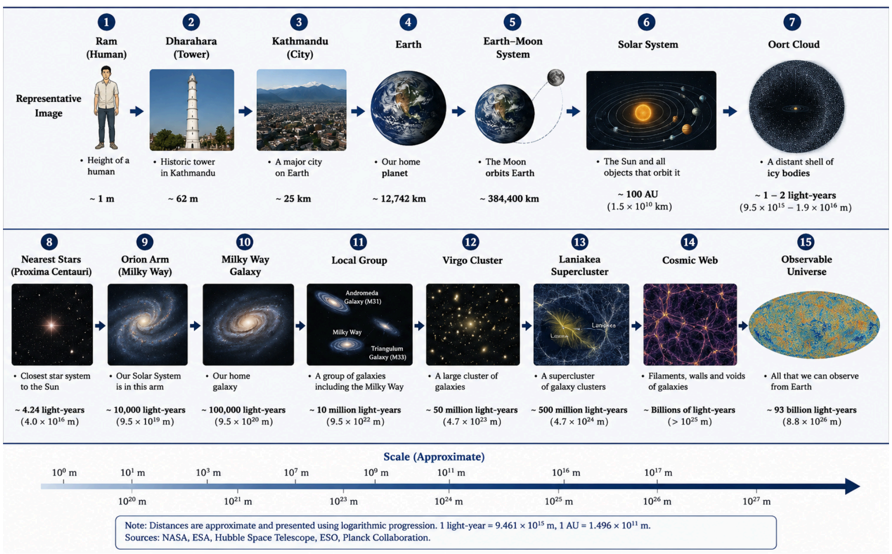

Figure 1.1: Hierarchical Scale of the Universe

1.2 Scientific Visualization in Astronomy

Scientific visualization plays a vital role in astronomy by transforming complex data and abstract concepts into visual representations that are easier to interpret and understand. Since astronomical objects cannot usually be observed together at their true relative sizes and distances, scientists use diagrams, computer simulations, and three-dimensional models to communicate the structure and scale of the universe. These visualizations help bridge the gap between numerical data and human perception, enabling learners to develop a more intuitive understanding of astronomical phenomena.

Traditional educational resources, such as textbooks and printed diagrams, are valuable for introducing fundamental concepts but often simplify or distort scale for practical reasons. Planets are commonly enlarged to remain visible, while the vast distances between celestial bodies are greatly compressed. Although these simplifications improve readability, they can lead to misconceptions about the actual size, separation, and organization of objects in the universe. Interactive digital visualizations overcome many of these limitations by allowing users to navigate freely through different scales while preserving the correct hierarchical relationships between astronomical structures.

The rapid advancement of web technologies has made it possible to create scientifically accurate three-dimensional models that are both accessible and interactive. By integrating verified astronomical data with logarithmic scaling and real-time visualization, educational web applications can provide a more immersive learning experience than conventional two-dimensional illustrations. Such visualizations not only improve conceptual understanding but also encourage curiosity, exploration, and a deeper appreciation of the immense scale and complexity of the universe.

CHAPTER II

2 Objectives

1. To study the hierarchical structure of the universe from the human scale to the observable universe using scientifically accepted astronomical concepts and data.

2. To design and develop an interactive three-dimensional web-based model using HTML, CSS, and JavaScript that accurately represents the scale and organization of major astronomical structures.

3. To visualize the immense differences in size and distance between celestial objects through scientifically accurate models, logarithmic scaling, and interactive exploration.

4. To demonstrate the effectiveness of interactive scientific visualization in enhancing the understanding of astronomy and encouraging greater interest in space science.

CHAPTER III

3 Theory

The model developed in this project is based on the hierarchical arrangement of physical and astronomical structures according to their characteristic size. The selected scales extend from approximately one metre at the human level to about 10^{27} meters at the scale of the observable universe. Since this range covers more than twenty-six orders of magnitude, it cannot be represented effectively using a single linear scale. The project therefore organizes the universe into distinct levels and uses logarithmic progression to preserve their scientific order while keeping each structure visible and understandable.

3.1 Human Scale

The human scale provides the starting reference for the model because measurements such as metres are familiar and easy to visualize. In the website, this level is represented by a character named Ram, modeled with an approximate height of 1.7 m. This is a chosen reference value rather than a claim about the average height of all people.

Beginning with a human figure allows later structures to be compared with something directly recognizable. As the user moves outward through the model, Ram gradually becomes too small to remain visible, demonstrating how quickly human dimensions become insignificant at geographic and astronomical scales.

3.2 Dharahara

Dharahara is used as the second reference level because it provides a recognizable transition between a person and a city. The reconstructed Dharahara is approximately 72 m high and is located in Kathmandu, Nepal [4]. Compared with Ram, the tower is more than forty times taller.

Although Dharahara is large from a human perspective, it remains extremely small when compared with geographic and planetary structures. Its inclusion also localizes the model by beginning the journey through the universe with a familiar Nepali landmark.

3.3 Kathmandu

Kathmandu represents the city scale in the project. At this level, individual people and buildings are no longer the main focus. Instead, the model shows a dense urban region situated within valley-like terrain and surrounded by elevated ridges.

The transition from Dharahara to Kathmandu demonstrates that a city is not a single object but a connected system of buildings, roads, open spaces, and natural geographical features. However, even an entire city becomes extremely small when viewed at the scale of Earth.

3.4 Earth

Earth is the third planet from the Sun and the only astronomical body currently known to support life. It has a mean diameter of approximately 12,742 km, making it vastly larger than any human-built structure [1]. Earth is approximately spherical, although its rotation causes a slight widening around the equator and flattening near the poles.

The planet consists of a rocky interior, a surface containing continents and oceans, and an atmosphere held by gravity. In the model, Earth marks the transition from geographic scale to planetary scale. Kathmandu becomes only a tiny region on its surface, showing that even large cities occupy a very small part of the planet.

3.5 Earth-Moon System

The Moon is Earth's natural satellite and orbits at an average centre-to-centre distance of approximately 384,400 km [1]. Earth has a mean diameter of about 12,742 km, while the Moon has a diameter of approximately 3,475 km [1]. Therefore, the average Earth-Moon distance is about thirty times Earth's diameter.

Diagrams often place the Moon close to Earth so that both objects can fit on the same page. This can create a misleading impression of their actual separation. The website attempts to emphasize the large amount of empty space between the two bodies while maintaining their approximate relative sizes.

The Earth-Moon system also introduces the concept of orbital motion. Earth's gravity keeps the Moon in orbit, while both bodies move around a common centre of mass.

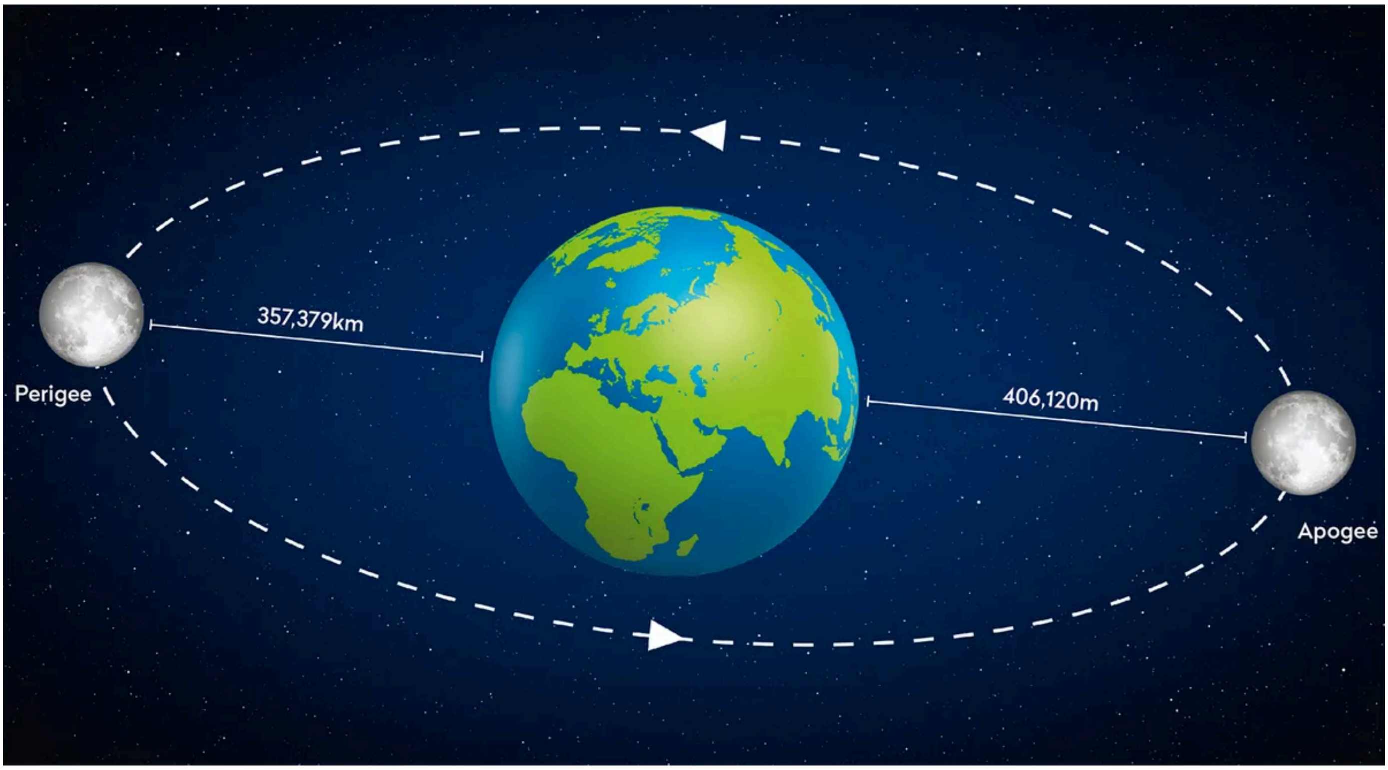

Figure 3.1: Earth–Moon System

3.6 Solar System

The Solar System consists of the Sun and all objects gravitationally bound to it, including eight planets, dwarf planets, moons, asteroids, comets, and smaller bodies. The planets are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune [1].

Astronomical units are commonly used to describe distances within the Solar System. One astronomical unit, or AU, is approximately equal to the average distance between Earth and the Sun. Neptune orbits at an average distance of about 30 AU, meaning that the planetary region extending across Neptune's orbit is roughly 60 AU wide [1].

Most diagrams enlarge the planets and compress their orbital distances. In reality, the planets occupy only a tiny fraction of the space between their orbits. At this scale, Earth is represented as a very small point, while the Sun becomes the dominant object.

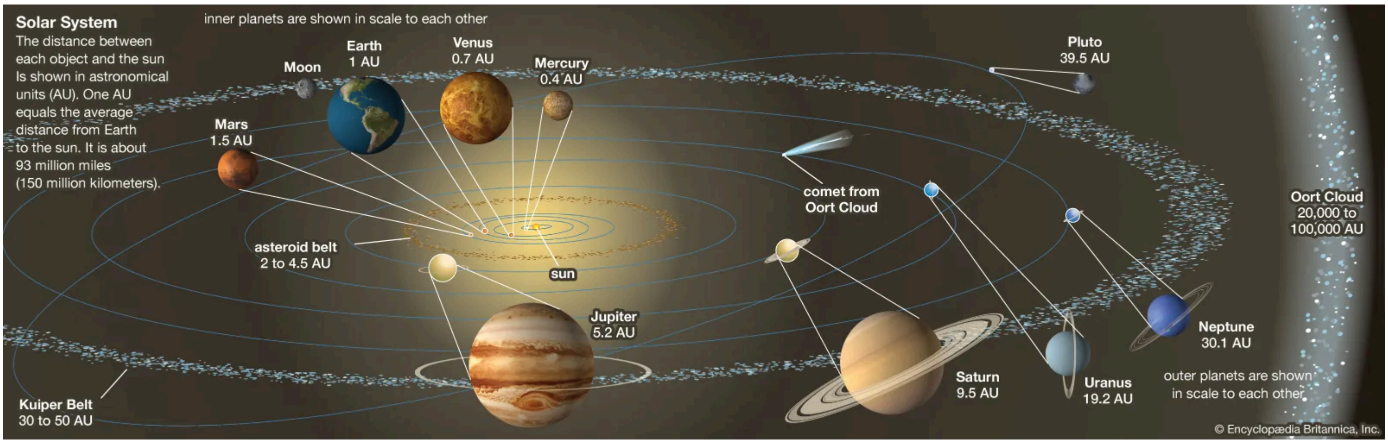

Figure 3.2: Structure and Extent of the Solar System

3.7 Oort Cloud

The Oort Cloud is a theoretical reservoir of icy bodies surrounding the Solar System. It is believed to be the principal source of many long-period comets that enter the inner Solar System [5]. Unlike the relatively flat planetary system, the outer Oort Cloud is expected to form a broadly spherical distribution around the Sun.

Its exact boundaries are uncertain because it has never been directly observed as a complete structure. Scientific models generally place its inner and outer regions at distances ranging from several thousand to approximately 100,000 AU from the Sun [5]. At such distances, the gravitational influence of nearby stars and the Milky Way can disturb icy objects and redirect some of them toward the inner Solar System.

In the visualization, the Oort Cloud is shown as a sparse distribution of small bodies rather than a solid shell. This prevents the model from suggesting that it is a continuous physical surface.

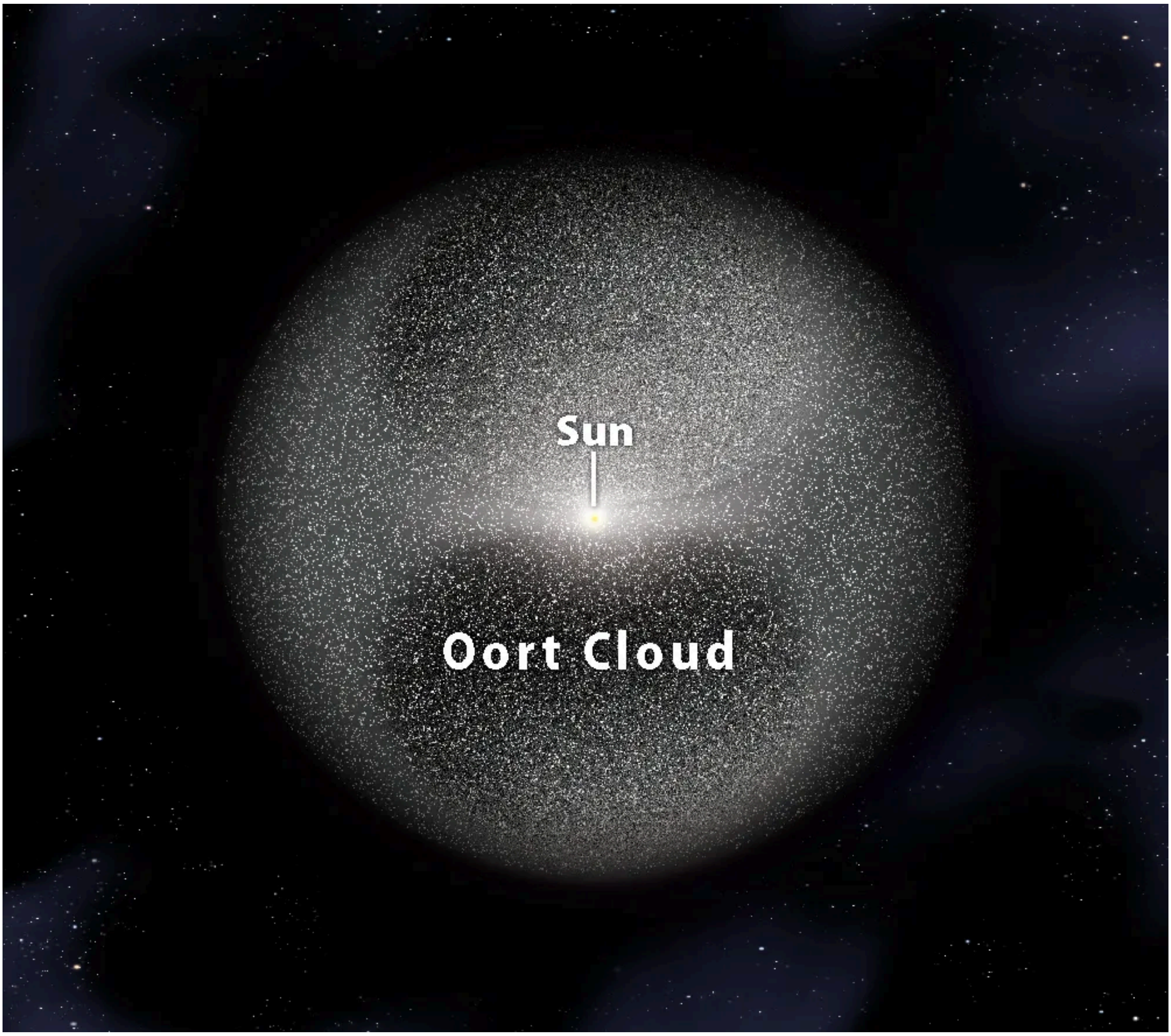

Figure 3.3: Structure and Estimated Extent of the Oort Cloud

3.8 Nearest Stars

Beyond the outer Solar System lies interstellar space. The nearest known stellar system to the Sun is Alpha Centauri, located more than four light-years away. Even at the speed of light, travelling between the Sun and its nearest neighbouring stars would require several years.

The Gaia mission has significantly improved the measurement of stellar positions, distances, brightness, and motion. Its data allow scientists to construct increasingly detailed three-dimensional maps of the Sun's stellar neighbourhood and the wider Milky Way [6].

At this scale, the entire Solar System becomes only a small marker among nearby stars. The large gaps between stars demonstrate that galaxies are mostly empty space despite containing enormous numbers of stars.

3.9 Orion Arm of the Milky Way

The Solar System lies within a nearby spiral structure of the Milky Way known as the Local Arm or Orion Arm. This structure is located between the larger Sagittarius and Perseus spiral arms. Observations of star-forming regions and precise distance measurements indicate that the Local Arm is a significant and extended feature of the Milky Way rather than merely a short and isolated spur [7].

The Orion Arm contains stars, gas clouds, nebulae, and regions where new stars are forming. At this scale, individual nearby stars merge into a much larger stellar environment, while the Solar System becomes a tiny highlighted point within the arm.

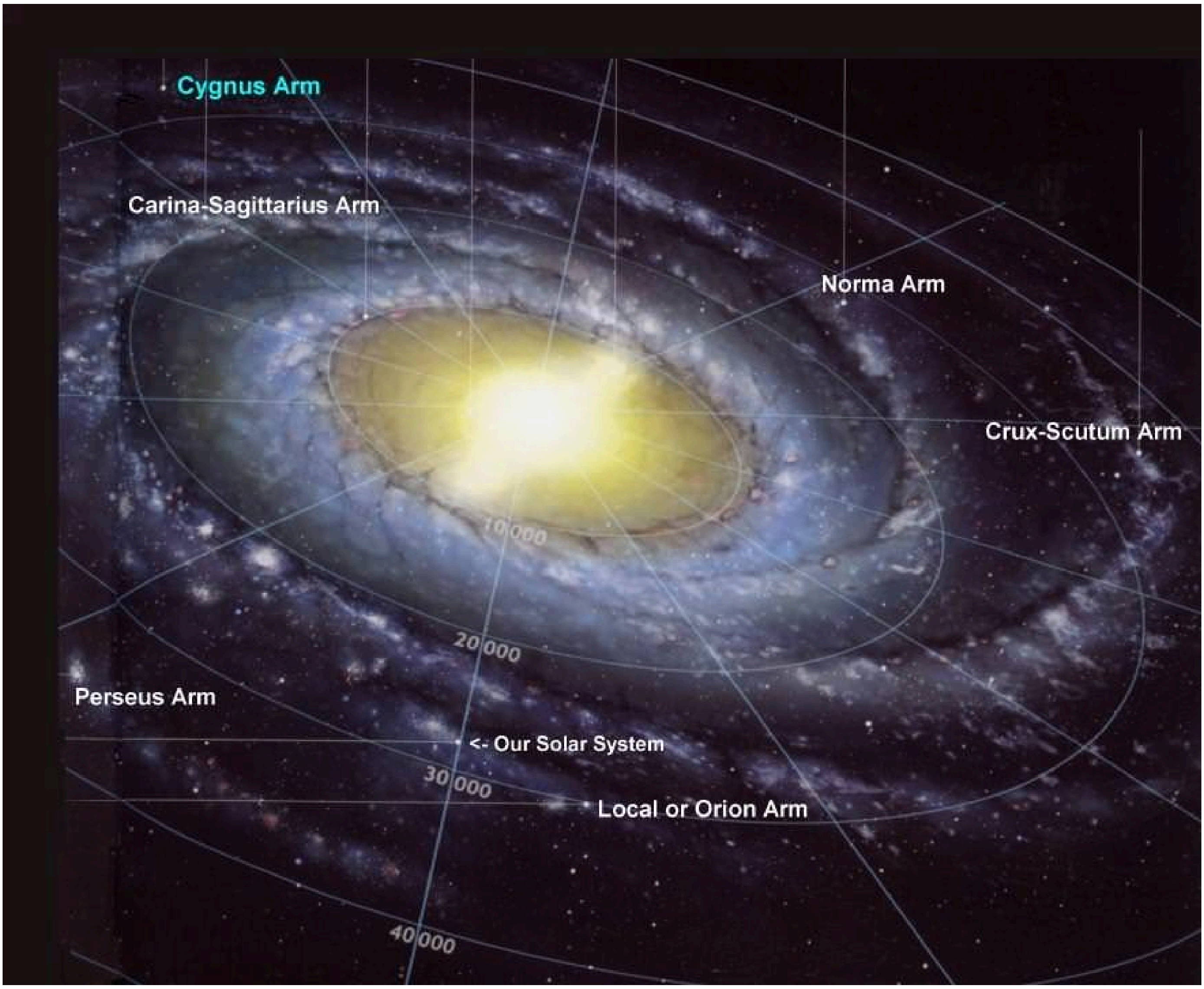

Figure 3.4: Position of the Solar System in the Orion Arm of the Milky Way

3.10 Milky Way

The Milky Way is the galaxy containing the Solar System. It is a barred spiral galaxy composed of stars, gas, dust, stellar remnants, and dark matter. Its visible disc is approximately 100,000 light-years across,

although its surrounding halo extends considerably farther.[6]

Large astronomical surveys, particularly the Gaia mission, have improved scientific understanding of the structure and motion of stars within the Milky Way [6]. The Sun is located in the Orion Arm and is positioned far from the galactic centre [7].

The galaxy contains a central bulge, a flattened disc, spiral structures, and an extended halo. At this level, the entire Solar System becomes effectively invisible unless shown using a marker. This illustrates the enormous difference between the size of a planetary system and that of a galaxy.

3.11 Local Group

The Milky Way belongs to a collection of nearby galaxies known as the Local Group. Its major members include the Milky Way, the Andromeda Galaxy, and the Triangulum Galaxy, together with numerous dwarf galaxies and smaller systems [8].

The Milky Way and Andromeda are the two dominant galaxies of the group. Many smaller galaxies orbit or interact gravitationally with them. The Local Group extends across several million light-years, meaning that even entire galaxies are separated by extremely large distances.

At this scale, galaxies are represented as individual islands of stars rather than as detailed stellar systems.

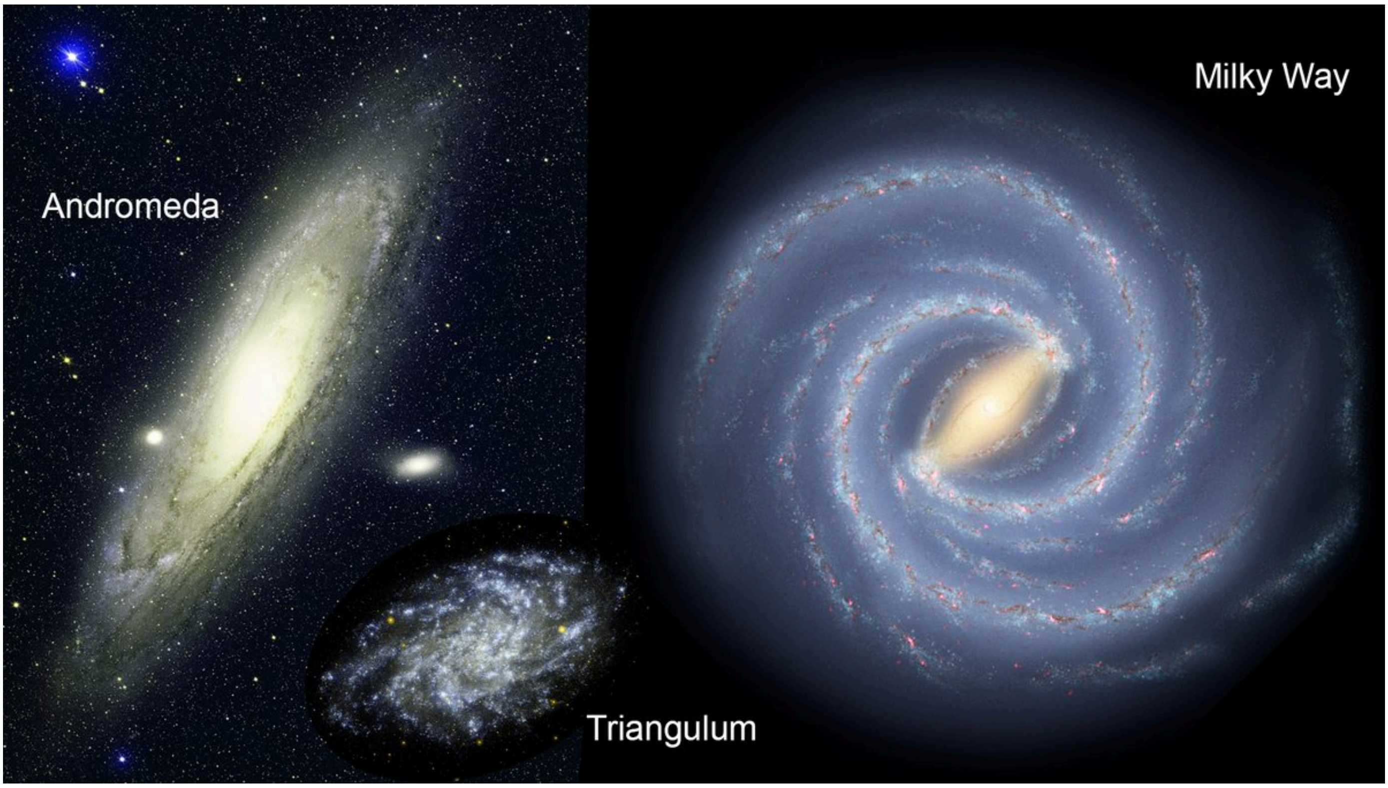

Figure 3.5: Major Galaxies of the Local Group

3.12 Virgo Cluster

The Virgo Cluster is the nearest large galaxy cluster to the Local Group. It is located approximately 54 million light-years away and contains a dense concentration of galaxies [9]. One of its most prominent members is the giant elliptical galaxy Messier 87, commonly known as M87.

Unlike the Local Group, which contains a relatively small collection of galaxies, the Virgo Cluster includes a much larger gravitationally associated population. Its members include spiral, elliptical, lenticular, and dwarf galaxies.

At the Virgo Cluster scale, the Milky Way is no longer represented as a major structure. It becomes one galaxy among many within the broader nearby universe.

Figure 3.6: Structure of the Virgo Cluster

3.13 Laniakea Supercluster

Galaxy clusters and groups are themselves distributed within still larger regions. The Laniakea Supercluster was defined through measurements of galaxy motions and gravitational flow patterns. It includes the region containing the Local Group and the Virgo Cluster [10].

Laniakea extends across roughly 500 million light-years and contains many galaxy groups and clusters moving within a shared large-scale gravitational environment [10]. However, a supercluster is not necessarily a completely gravitationally bound object. The expansion of the universe influences the motion of matter across such enormous distances.

In the model, individual galaxies are replaced by brighter nodes and streams representing the distribution of galaxy groups and clusters.

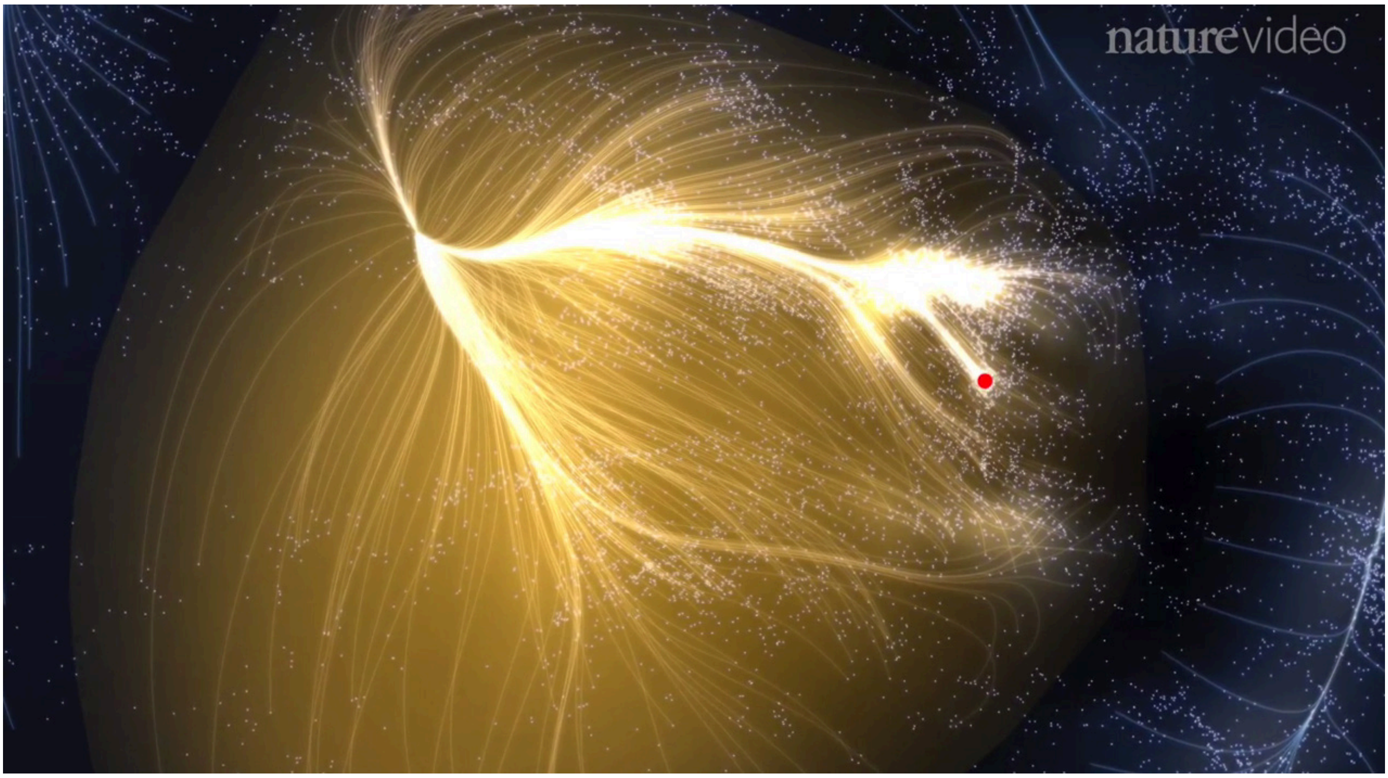

Figure 3.7: Structure of the Laniakea Supercluster

3.14 Cosmic Web

On the largest scales, matter is not distributed uniformly. Galaxies and galaxy clusters form an enormous network known as the cosmic web. This structure consists of dense nodes, elongated filaments, sheet-like walls, and large regions containing comparatively little matter called voids [2].

The cosmic web developed through the gravitational growth of small density differences in the early universe. Regions containing slightly more matter attracted additional material and eventually formed galaxies, clusters, and filaments. Regions with less matter developed into expanding voids. Large cosmological simulations reproduce this web-like arrangement and help scientists study the formation and clustering of galaxies over cosmic time [11].

The visualization must therefore avoid showing the cosmic web as a random network of equally spaced lines and spheres. Instead, it should display irregular filaments, dense intersections, and extensive dark voids.

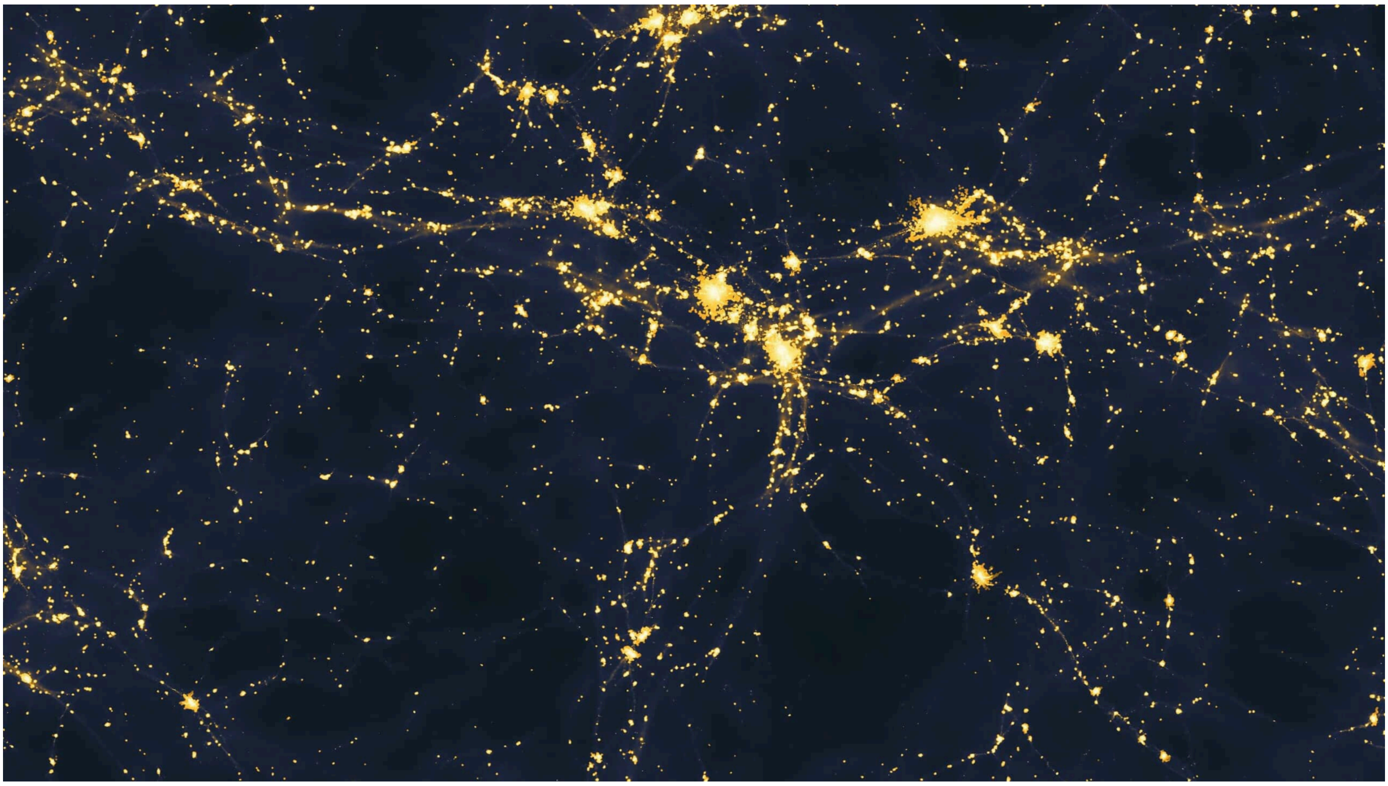

Figure 3.8: Filaments and Voids of the Cosmic Web

3.15 Observable Universe

The observable universe is the region from which light or other signals have had sufficient time to reach Earth since the beginning of cosmic expansion. It does not necessarily represent the entire universe. Regions beyond the observable horizon may exist, but their light has not reached us.

According to measurements used in the standard cosmological model, the universe is approximately 13.8 billion years old [3]. However, because space has expanded while light has travelled, the present-day diameter of the observable universe is approximately 93 billion light-years.

The observable universe contains the visible portion of the cosmic web, including galaxies, galaxy clusters, filaments, and voids. Its spherical appearance in diagrams does not represent a physical wall. It represents an observational horizon centred on the observer.

In the final level of the model, all previously explored structures become extremely small compared with the full observable region. This provides the final perspective of the project by showing that humans, cities, planets, stars, galaxies, and even superclusters occupy only parts of a far larger cosmic structure.

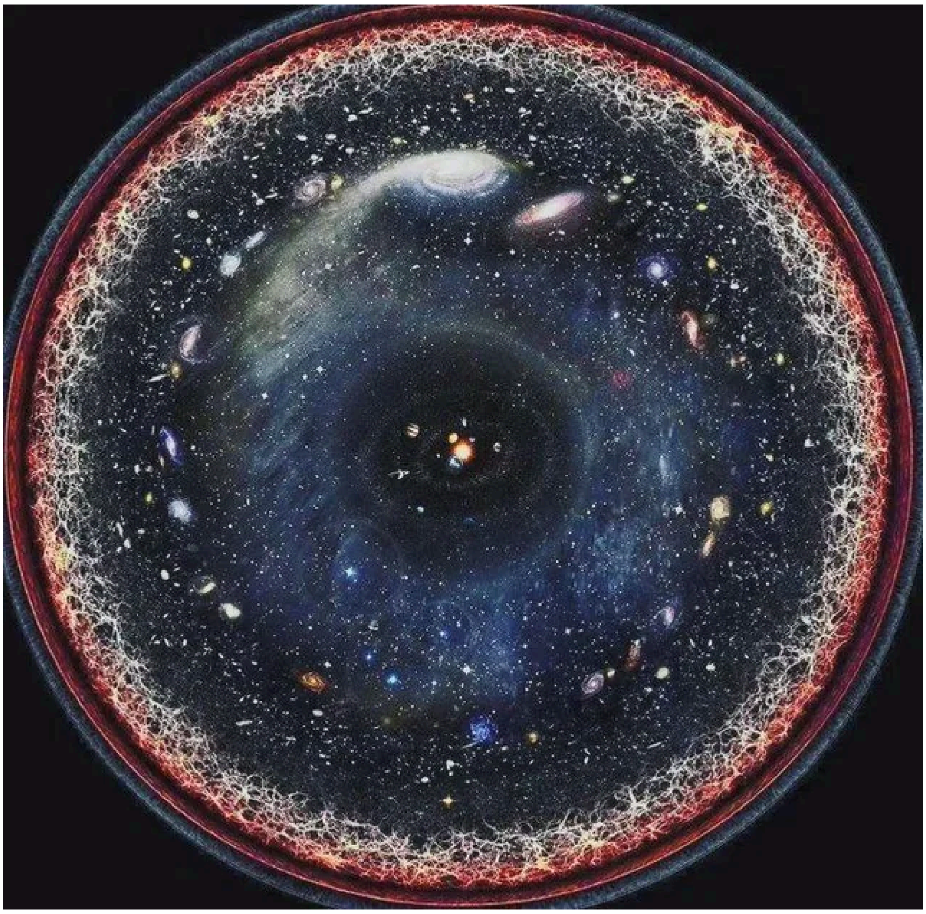

Figure 3.9: Extent of the Observable Universe

CHAPTER IV

4 Material Required and Methodology

The following materials and resources were used to develop the project:

- A laptop or desktop computer
- Internet connection for scientific research and data verification
- HTML for structuring the webpage
- CSS for designing the interface and layout
- JavaScript for interaction, animation, and scale transitions
- Three.js library for rendering three-dimensional objects
- Scientific diagrams, astronomical data, and reference measurements
- Web browser for testing and refinement

The project began with the collection and verification of scientific information related to the major scales represented in the model. Measurements and structural descriptions were gathered from official astronomical databases and peer-reviewed scientific studies covering planetary dimensions, the Earth–Moon system, the Solar System, the Oort Cloud, nearby stars, the Milky Way, galaxy groups, clusters, superclusters, the cosmic web, and the observable universe. The selected levels were then arranged in a continuous hierarchy beginning with a human figure and local landmarks before progressing toward increasingly larger astronomical structures.

Because the difference between the smallest and largest scales extends across many orders of magnitude, a direct linear representation was not practical. A logarithmic progression was therefore used to compress the differences in size while preserving the correct sequence and relative hierarchy of the objects. Familiar references such as Ram, Dharahara, and Kathmandu were included at the beginning so that users could relate everyday scales to planetary and cosmic scales. Each level was designed with a corresponding three-dimensional representation, explanatory text, scale information, and perspective facts.

The website was developed using HTML, CSS, JavaScript, and Three.js. HTML was used to organize the content, CSS was used to create the visual layout and responsive interface, and JavaScript controlled the navigation, transitions, animations, and interaction between different scales. Three.js was used to generate and display the three-dimensional models within the browser. The completed website was repeatedly tested to check the accuracy of labels, scale order, object visibility, transitions, responsiveness, and overall user experience. Necessary adjustments were made to improve scientific clarity, visual balance, and ease of navigation.

```
  },
  { name: "Earth", reference: "Planet Earth", metricLabel: "Diameter", metric: "12,742 km", location: "Solar System", description: "A living planet with oceans, continents,
  { name: "Earth-Moon System", reference: "Earth and Moon", metricLabel: "Average distance", metric: "384,400 km", location: "Near-Earth space", description: "Earth sits at
  { name: "Solar System", reference: "Sun and planets", metricLabel: "Scale", metric: "100+ AU", location: "Sun's planetary system", description: "Planet markers, orbital pa
  { name: "Oort Cloud", reference: "Comet cloud", metricLabel: "Outer reach", metric: "~100,000 AU", location: "Solar boundary", description: "The Solar System shrinks into
  { name: "Nearest Stars", reference: "Nearby stellar neighborhood", metricLabel: "Scale", metric: "Several light-years", location: "Local interstellar space", description:
  { name: "Orion Arm", reference: "Local spiral arm", metricLabel: "Scale", metric: "Thousands of light-years", location: "Milky Way", description: "Nearby stars dissolve i
  { name: "Milky Way", reference: "Home galaxy", metricLabel: "Diameter", metric: "~100,000 light-years", location: "Local Group", description: "A full spiral galaxy appear
  { name: "Local Group", reference: "Galaxy group", metricLabel: "Scale", metric: "~10 million light-years", location: "Local Group", description: "The Milky Way, Andromeda
  { name: "Virgo Cluster", reference: "Galaxy cluster", metricLabel: "Scale", metric: "Tens of millions of light-years", location: "Virgo region", description: "Hundreds of
  { name: "Laniakea Supercluster", reference: "Supercluster basin", metricLabel: "Scale", metric: "~520 million light-years", location: "Laniakea", description: "Galaxy clu
  { name: "Cosmic Web", reference: "Large-scale structure", metricLabel: "Scale", metric: "Billions of light-years", location: "Observable cosmos", description: "Glowing fi
  { name: "Observable Universe", reference: "Cosmic horizon", metricLabel: "Diameter", metric: "~93 billion light-years", location: "Observable universe", description: "The
];


const journeyLabels = [
  "Human",
  "Dharahara",
  "Kathmandu",
  "Earth",
  "Earth-Moon System",
  "Solar System",
  "Oort Cloud",
  "Nearest Stars",
  "Orion Arm",
  "Milky Way",
  "Local Group",
  "Virgo Cluster",
  "Laniakea Supercluster",
  "Cosmic Web",
  "Observable Universe"
];

const state = {
  clock: new THREE.Clock(),
  zoom: 0,
  targetZoom: 0,
  zoomVelocity: 0,
  activeLevel: -1
```

Figure 4.1: Sample Source Code Used in the Interactive Visualization

CHAPTER V

5 Results and Discussion

The completed project successfully produced an interactive three-dimensional web-based model that presents the hierarchical scale of the universe through fifteen successive levels. The visualization begins with a human figure and familiar local references before progressing through planetary, stellar, galactic, and cosmological structures. Users can navigate between the levels using the scale-selection panel, while each scene includes explanatory information, approximate measurements, and perspective facts. Smooth transitions between the models help communicate how rapidly familiar objects become insignificant as the scale increases.

The first levels of the visualization use Ram, Dharahara, and Kathmandu to establish a familiar point of reference. Dharahara was particularly useful because it created a clear intermediate stage between human and city scales. Its model was developed using the official dimensions of the reconstructed structure [4]. The inclusion of a recognizable Nepali landmark also made the visualization more locally relevant and allowed the journey into space to begin from an environment familiar to the intended audience.

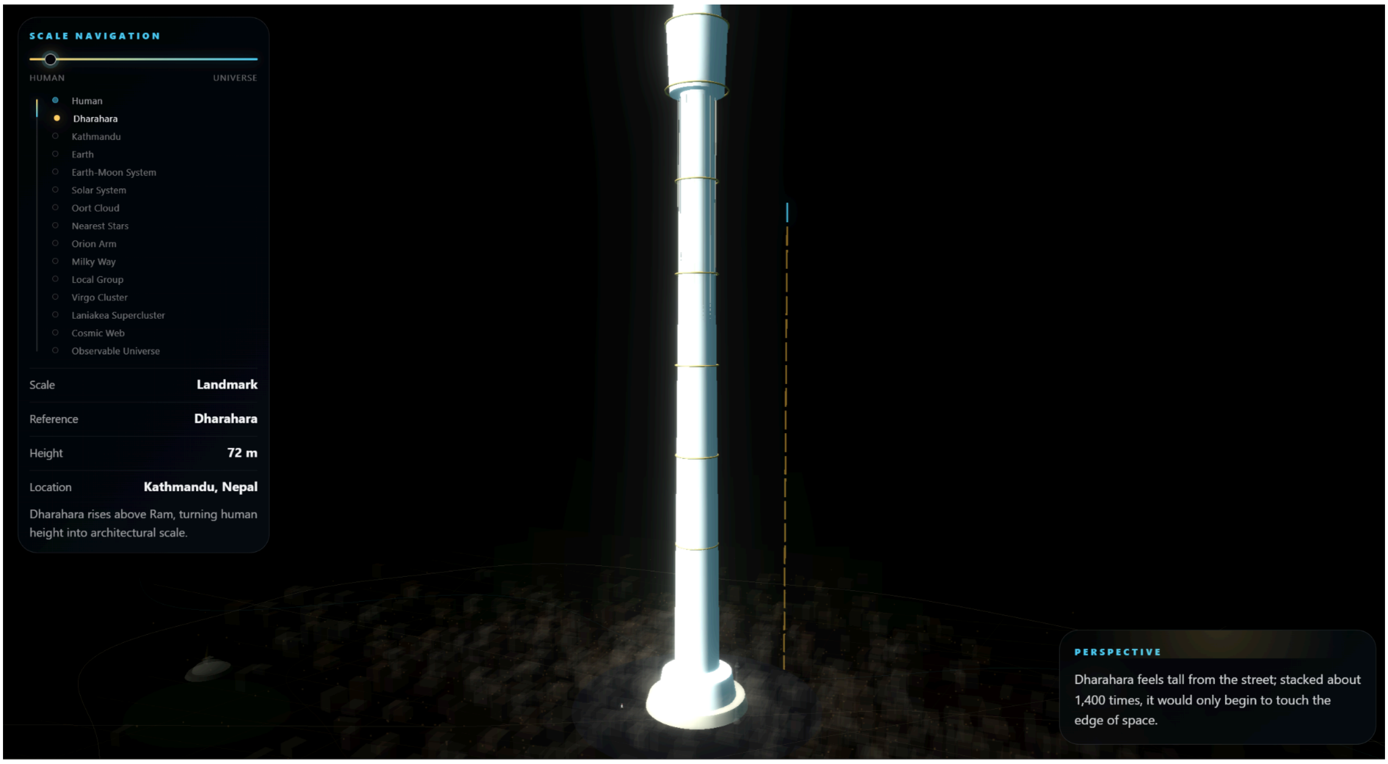

Figure 5.1: Dharahara Scale in the Completed Website

The Earth–Moon scene was one of the most effective results of the project. Many conventional diagrams place the Moon very close to Earth so that both objects remain visible on the same page. In reality, the average Earth–Moon distance is approximately 384,400 km, which is about thirty times the diameter of Earth [1]. The completed visualization emphasizes the large region of empty space between the two bodies and therefore provides a more realistic impression of their relationship.

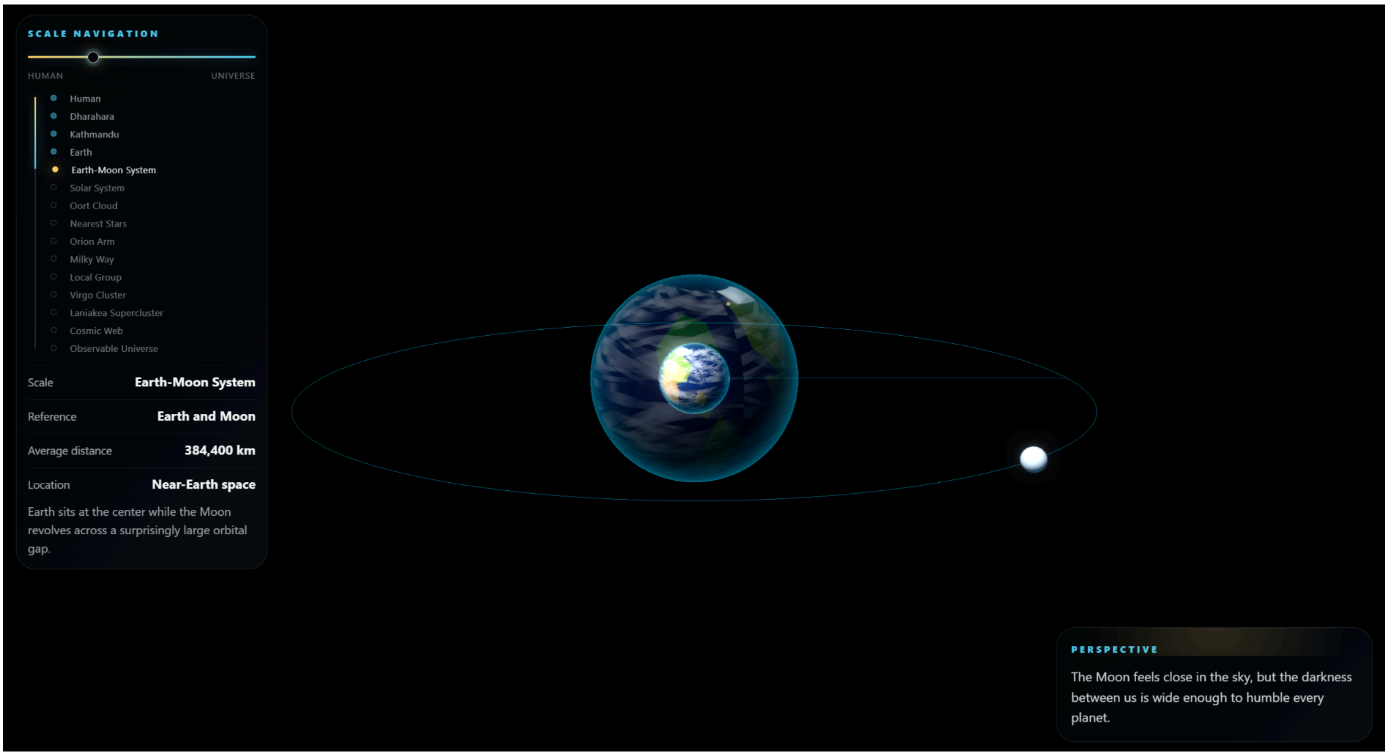

Figure 5.2: Earth–Moon System in the Completed Website

At the Solar System scale, the planets were arranged according to their order from the Sun and their approximate orbital relationships. The visualization showed that the planets occupy only a small portion of the space enclosed by their orbits. However, representing the true sizes of the planets and their exact orbital distances simultaneously would make most planets nearly invisible. The scene therefore uses controlled visual enlargement while preserving the correct order and broad hierarchy of the planetary system. This compromise improves clarity while still communicating the immense separation between celestial objects.

The Oort Cloud scene presented a different challenge because the structure has not been directly observed as a complete physical object. It is understood through the study of long-period comets and dynamical models, which suggest a sparse, broadly spherical distribution of icy bodies surrounding the Solar System [5]. For this reason, the completed model represents the Oort Cloud as a large collection of scattered particles rather than as a solid shell. This design more accurately reflects its theoretical and low-density nature.

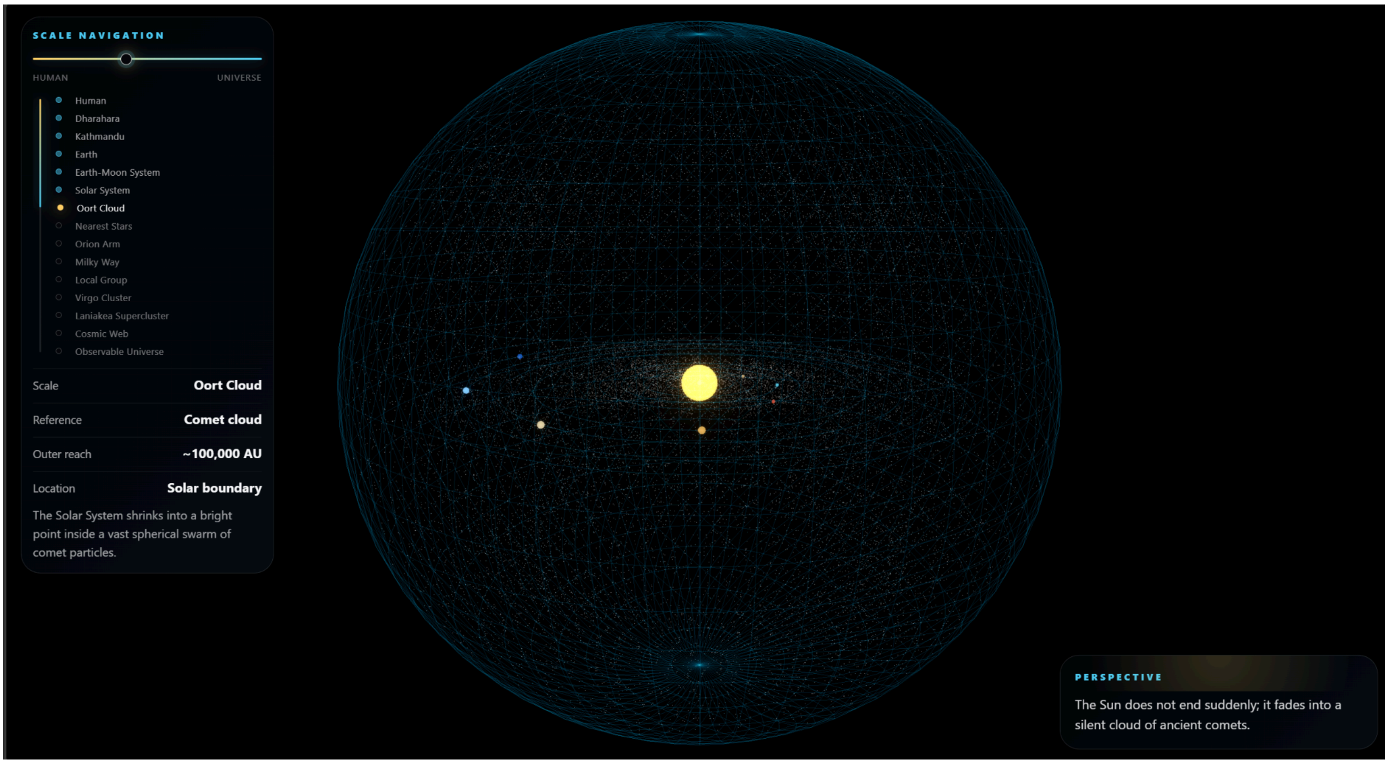

Figure 5.3: Oort Cloud in the Completed Website

The stellar and galactic scenes successfully demonstrated the transition from individual stars to much larger organized structures. At the nearest-stars level, the Solar System becomes a small marker within interstellar space. The Orion Arm scene then places the Sun within the Local Arm of the Milky Way, reflecting modern studies of the nearby spiral structure [7]. At the Milky Way level, the Solar System is no longer visible without a highlighted marker, which effectively demonstrates the enormous difference between a planetary system and a galaxy.

The Local Group scene showed the Milky Way, the Andromeda Galaxy, the Triangulum Galaxy, and smaller surrounding galaxies as separate galactic systems. The scene visually communicates that the Milky Way is only one member of a larger galactic neighbourhood [8]. The major galaxies were made more prominent than the dwarf galaxies so that the hierarchy remained understandable, although their precise positions and sizes were simplified for clarity.

Figure 5.4: Local Group in the Completed Website

At still larger scales, the Virgo Cluster, Laniakea Supercluster, and cosmic web scenes demonstrated how galaxies are grouped into increasingly complex structures. The Laniakea scene used stream-like patterns to represent the motion of galaxy groups within a shared large-scale region, following the flow-based interpretation used to define the supercluster [10]. The cosmic web scene represented matter as dense nodes connected by irregular filaments and separated by large dark voids. This is consistent with scientific descriptions and simulations in which the large-scale universe forms a network of clusters, filaments, walls, and voids [2, 11].

The observable-universe scene formed the final and largest level of the website. It was represented as an approximately spherical observable region containing the cosmic web. In the standard cosmological model, the observable universe has a present-day diameter of roughly 93 billion light-years, despite the universe being approximately 13.8 billion years old, because space expanded while light travelled toward the observer [3]. The boundary shown in the model is therefore not intended to represent a physical wall. It represents the observational horizon beyond which light has not yet reached Earth.

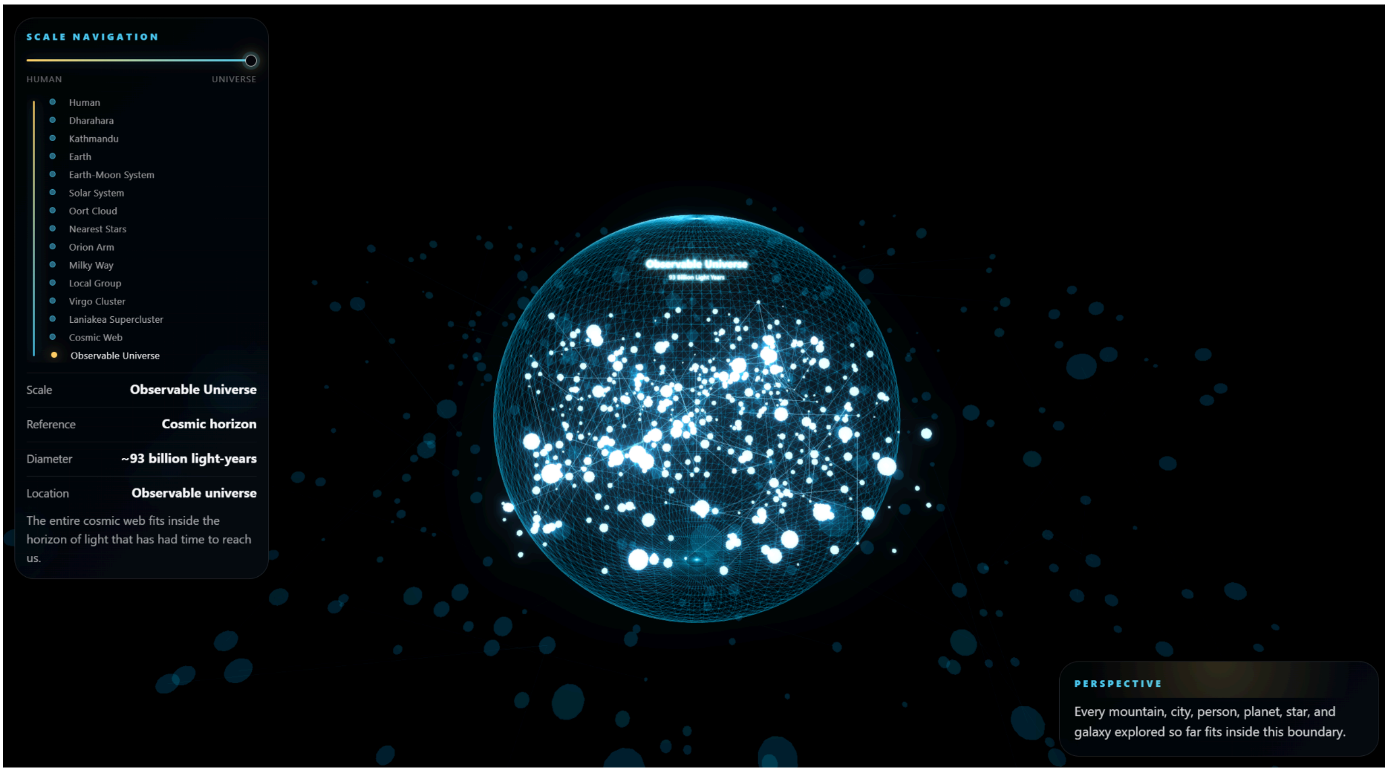

Figure 5.5: Observable Universe in the Completed Website

Overall, the project achieved its main purpose of making extremely large differences in scale easier to understand. The gradual movement from local objects to the observable universe created a clearer sense of hierarchy than separate diagrams would provide. The combination of three-dimensional models, explanatory panels, scale navigation, and perspective facts made the website both informative and engaging.

However, the project also has limitations. A completely accurate linear model of every selected structure is impossible within a single browser view because their dimensions differ by many orders of magnitude. Some objects were therefore enlarged, simplified, or represented symbolically. The Oort Cloud remains theoretical [5], the cosmic web is represented through a simplified simulation-like pattern [2, 11], and the observable-universe boundary is conceptual rather than physical [3]. These limitations were necessary to maintain visibility and usability while preserving the correct scientific sequence and overall relationships between the represented structures.

CHAPTER VI

6 Conclusions

This project successfully developed an interactive three-dimensional web-based model that presents the hierarchical scale of the universe from familiar human surroundings to the observable universe. By beginning with Ram, Dharahara, and Kathmandu before progressing through planetary, stellar, galactic, and cosmological structures, the visualization created a gradual and understandable journey across extremely different scales. This approach made it easier to recognize how rapidly human-sized objects become insignificant when compared with planets, solar systems, galaxies, and larger cosmic structures.

The use of logarithmic progression allowed objects separated by many orders of magnitude to be represented within a single interactive experience. Three-dimensional models, smooth transitions, scale navigation, scientific descriptions, and perspective facts were combined to make the visualization both educational and engaging. The completed website achieved the main objectives of the project by presenting scientifically ordered structures, improving the understanding of size and distance, and demonstrating the educational potential of interactive web technologies.

Certain simplifications were necessary because completely accurate sizes and distances cannot be shown simultaneously within one browser view. Some objects were enlarged, compressed, or represented symbolically so that they remained visible and understandable. Despite these limitations, the project preserved the correct sequence and broad relationships between the selected structures. Overall, the development of this model improved my understanding of astronomy, scientific visualization, and web-based three-dimensional design while demonstrating that complex scientific ideas can be communicated more effectively through interactive exploration.

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