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Space Exploration by *Sampati-Jatayu* Brothers in Ancient India

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Abstract

In this research paper, a scientific investigation on the space exploration, done in the ancient India, is being presented based on the vivid descriptions of the same available in one of the most ancient and revered Indian epic the Ramayana, written by the great seer, researcher and astronomer sage Maharshi Valmiki, in which one can find descriptions of two vulture brothers namely Sampati and Jatayu who made that journey in space and they had described egocentrically their observations about the Earth from space. However, in the full description of their space journey in that epic, nothing has been described about the height attained by them in numerical figures, and that is the point of study and focus of investigation of the present study and research work. Based on the textual descriptions of observations, it is interesting to look for the possibilities of estimation of their height of observation. To carry out the same, the empirical study made here is based on the very important textual depiction that they went up to the height, named here as J-S point, from where they had observed the Earth and the Sun of the same size. The modern scientific knowledge of space technology and related observations indicates that even from the surface of the Moon, the Earth looks bigger than the Sun as seen from the Earth's surface. The estimates of their heights of observation presented here are based on such lingual descriptions and their modern scientific interpretations that show that the Jatayu and Sampati (J-S) brothers observed the Earth from the distance of order of 10^6 km, which seems unbelievable and unacceptable, but the proposed calculations also confirm similar projections.

Keywords: Space exploration, Jatayu-Sampati Bro, space travel, visible spherical cap, size distance paradox, Earth's observation, ancient astronauts

INTRODUCTION

Looking at the things from height changes perspectives and related perceptions of the world have brought a run for space exploration, which is one of the most important achievements of the human race and has also led to many discoveries and creation of extremely advantageous technological leverages to our lives in the modern era [1]. The successful launch of the first artificial satellite by the Soviet Union in 1957 gave birth to the modern space age, which in turn also started the well-known US—USSR space race and rivalry. The technological research and developments made in this area have ensured today not only the regular presence of humans in space at the International Space Station (ISS) but also their access to the Moon, the Sun, and other planets and astronomical bodies. We are hopeful that someday in the future human feet will be on the Mars planet and other planets too. Today's space research activities focus on very important studies such as solar and space physics, including interactions of radiation and energetic particles with the Earth, evolution of current solar systems and universe, exploration of planets, moons, asteroids, comets, dust in the solar system, observation of the Earth from space, etc. The growth of modern space technology is very rapid and is playing a very transformative role in our lives. However, the

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imagination for a journey into space came forth in ancient times, which can be read in detail in many reported research works [2, 3]. It is well said that literature laureates or creative writers are half-scientists because many famous inventions, such as robots, missiles, etc., came to physical realization from their imaginations. The ancient history of space technology is also on similar footage, as one can find different stories in epics, fiction, and other ancient books of different civilizations and cultures across the globe [3]. Although the technological foundation of modern rocket engines for space flights was laid down by a Russian teacher, K.E. Tsiolkovsky of the Soviet Union in 1905, who contributed so much by his theoretical and philosophical research [4] that became a foundation stone for modern space flight and research, mainly in Russia and Europe. However, since antiquity, people around the world have developed the concept of heaven and other worlds and have gathered astronomical knowledge by observing the sky and other heavenly bodies. Many had dreamed of leaving the Earth to see beyond the atmospheric world. One of such interesting stories is of a Chinese Mandrin Wan Hu, now named as the world’s first astronaut in modern days, who made a fatal and abortive attempt to fly into space in 500 B.C. by igniting a number of rockets tied to a chair. However, he died in his bold attempt due to untuned and uncontrolled blasts in the rocket after covering some distance. In many other fictions, too, fictional journeys to the Moon and the Sun are described [2, 3, 5]. In this connection, it is also important to mention that Indian civilization has a very rich legacy of scientific achievements in the area of airflight, astronomy, space exploration, etc. One can find many related ancient texts, such as *Surya Sidhant, Vaimanika Shastra, Vedic Joytish, Aryabhatiya, Purans, Mahabharat,* etc., which describe flying machines, planetary motion, rotation of the Earth, and other related things in a scientific manner and to the great depth that emphatically ensure leadership, legacy and heritage of Indian knowledge.

Currently, India is also a country with acclaimed achievements in space technology and has made self-dependent progress with many stunning demonstrations. The developments in space technologies by the Indian Space Research Organization (ISRO) have brought India to the axis of nations racing for space research programs and achievements across the globe. A brief account of ISRO’s efforts and the explorative and probative space technology research programs can be seen in [6, 7], however, the genesis of research quests for space exploration in India is very old. In one of the greatest epics, the *Ramayana*, composed by the sage *Maharshi Valmiki* [8] somewhere between the time span of 5000–6000 B.C., the full description of the space journey made by the two vulture brothers is given as special chapter that tells that *Jatayu* and his elder brother *Samapati* made journey to outer space about 8000 years back from the *Ramayana* period [8]. Thus, the time-point of journey kick-off of *J-S brothers* in space can be assumed somewhere in the timeline span of 14000-13000 B.C. [9–11] when J-S brothers were at the onset of adulthood. The said epic describes the appetite of vultures for long-distance travel, which has also been confirmed by one of the modern studies reported on African white-backed vultures that emphasizes such a behavioral attitude of vultures for very large distance travel in their daily lives [12]. As stated in the *Ramayana*, J-S brothers were not ordinary birds; they were celestial beings and had a genetic lineage of vulture and *Garuda (*Eagle) from their parental sides. *Jatayu* was younger than *Sampati,* and both of them, during the blossoming of their youth, challenged each other to fly up in space from the *Kailash* Mountain to prove their competencies. In that race in space, the elder brother *Sampati* took a lead initially, but the more juvenile *Jatayu* impulsively put his whole effort and reached near the outer orbit of the Hill sphere of the Sun, called *Suryamandal or* the Sun path in the *Ramayana*, where *Jatayu* got damaged due to scorching heat. But the elder brother *Sampati* reached there and rescued *Jatayu* by sheltering him under the shadow of his wings, which ultimately saved *Jatayu* but damaged *Sampati* horribly. The elder brother *Sampati* lost control on his downward journey and fell like a stone. However, *Jatayu* descended, controlling his flight, but he got separated from *Sampati* forever. It is their experiences of flight and observations in space that have been described in the epic *Ramayana* in Sanskrit in the egocentric sense by *Sampati*. The author of the epic, *Maharshi Valmiki,* had great astronomical sense, which can be seen in the epic in the descriptions of the association of astronomical phenomena and related planetary positions with the events that happened in the life of Lord Rama, a key divine character of the epic. All such descriptions of planetary position have also been verified using Planetarium Gold software [10, 11, 13]. The different verses of *Ramayana* give descriptions of the height profile of the atmosphere through which different avian birds can fly, and accordingly, different levels of airpaths have also been described as given below:

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श्येनाः चतुर्थम् गच्छन्ति गृध्रा गच्छन्ति पंचमम् |बल वीर्य उपपन्नानाम् रूप यौवन शालिनाम् ||४-५८-२८
षष्ठः तु पन्था हंसानाम् वैनतेय गतिः परा| वैनतेयात् च नः जन्म सर्वेषाम् वानरर्षभाः || ४-५८-२९

śyenāḥ chaturthaṃ gacchanti gṛdhrā gacchanti pañcamam |
bala vīrya upapannānām rūpa yauvana śālinām ||4-58-28
ṣaṣṭhaḥ tu panthā haṃsānām vainateya gatiḥ parā |
vainateyāt ca naḥ janma sarveṣām vānararṣabhāḥ || 4-58-29

Which means *"The fourth flight level is that of hawks and the fifth is that of vultures [4-58-28].And the sixth flight level is that of the swans, which derive their valor, vigor, handsomeness, and youthfulness from their majestic birth. But the uppermost path is that of the sons of Lady Vinata, namely the Divine Eagle Garuda, and Anuuru, the non-stopping charioteer of the Sun. Because we eagles have our lineal descent from the Divine Eagle, we can soar to the uppermost flyable path and see keenly" [4-58–29].*

The observations of objects from height change perspectives and how the size of objects appears smaller when observed from height have also been described as follows:

उपलैः इव संछन्ना दृश्यते भूः शिल उच्चयैः |
आपगाभिः च संवीता सूत्रैः इव वसुंधरा || ४-६१-८

"Upale iva saṅghā dṛśyante bhūḥ śila uccayaḥ |
āpaṇāḥ ca saṅkīrṇā mṛte iva vaṃśadharā || 4-9-8"

The meaning of this Sanskrit verse is that from there (space) the Earth covered with pebbles like mountain heights appeared shingly, and interwoven with yarn like rivers the surface of the Earth is thready... [4-61-8]

हिमवान् चैव विन्ध्यः च मेरुः च सुमहान् गिरिः |
भू तले संप्रकाशन्ते नागा इव जल आशये || ४-६१-९

"Himavān caiva Vindhyaś ca Meruś ca sumahān giriḥ |
bhūtale saṅkāśyante nāgā iva jala āśaye || 4-9-9"

The meaning of this is that Himalayas, even Mt. Vindhya, and even the very high mountain Mt. Meru, shone forth like elephants in lakes... [4-61-9]

The main purpose of quoting these lines from the epic *Ramayana* is to show that if the Earth is observed from a height, the things on it are perceived in miniaturized form, and such knowledge in the mind of the Maharshi Valmiki, author of the great epic Ramayana, decidedly represents the special awareness and very rich body of knowledge of space exploration science that he had earned in ancient times. The space travel journey of *J-S* brother is described in more than 20 verses in *Sanskrit* that provide information about the observation of the Earth from increasing heights in the course of their journey into space. It has been described with examples of observations of *Mount Kailash*, *Himalayas*, *Mt. Vindhya*, *Mt. Meru,* and other mountains, which were observed as small pebbles placed on the Earth, and observations of different rivers of the Earth appeared to the J-S brothers as if the Earth was wrapped by threads. It has also been described how much smaller, like the wheel of a chariot, the J-S brothers were observed from the surface of the Earth in a comparative style. In addition, there is another verse that depicts that the J-S brothers went up to their maximum height in the space from where the Earth and the Sun appeared to them of the same size, as can be seen in verse [8], placed as part (a) of Figure 1. Part *(b)* of the same figure portrays the meaning of the *Sanskrit* verse in the geometrical form. Such systematic descriptions of observation of the Earth from handsome height, explorative knowledge about the space in Indian texts of the deep B.C. periods, certainly indicates wider and bigger development and achievements obtained in this area by Indian scholars in the antiquity.

In modern times, the first photograph of the ground from a height of 80 meters was taken by a French balloonist named Nadar in 1856, from where knowledge of aerial photographs originated, and different ideas of its application emerged. The history of aerial photography of the Earth has gone through its own course of development, and its application scenario met a turning point with the launch of the first artificial satellite, Sputnik, in 1957 by the USSR. Since then, the number of Earth-observing satellites has increased rapidly. At present, there are 14720 Earth observatory satellites, which have led to many important technological developments on the ground for the betterment of our lives. However, such a discussion is beyond the scope of this paper, and details can be found in references [14, 15].

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(a)

मनः च मे हतम् भूयः चक्षुः प्राप्य तु संश्रयम् |
यत्नेन महता हि अस्मिन् मनः संधाय चक्षुषी || ४-६१-१२
यत्नेन महता भूयो भास्करः प्रतिलोकितः |
तुल्यः पृथ्वी प्रमाणेन भास्करः प्रतिभाति नौ || ४-६१-१३

Manaḥ cha me hatam bhūyaḥ chakṣuḥ prāpya tu sanśrayam |
Yatnena mahatā hi asmin manaḥ sandhāya chakṣuṣī || 4-61-12
Yatnena mahatā bhūyo bhāskaraḥ pratilokitaḥ |
Tulyaḥ pṛthvī pramāṇena bhāskaraḥ pratibhāti nau|| 4-61-13

"Though my brainpower is deranged, I again tried laboriously, just depending on my sight. I again tried strenuously concentrating my brainpower and sight on the Sun, and I have directly seen the Sun. Then the Sun appeared in a size equal to the Earth. [4-61-12 and 13]"

(b)

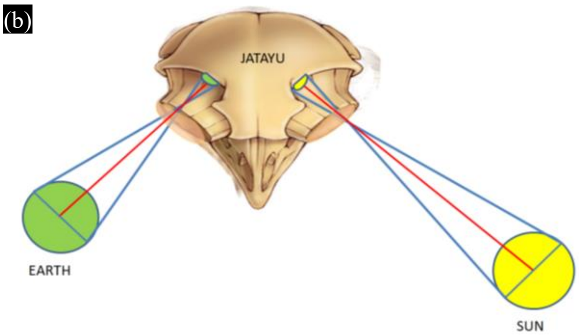

Figure 1. (a) The observation of the Earth and the Sun by J-S brothers as described in the *Sanskrit* in *the Ramayana of Maharshi Balmiki*. (b) Portrays geometrically meaning of this verse which is one of the most ancient descriptions to says that the Earth and the Sun appeared of equal size from space which in turn indicates that the Earth was observed round or spherical like the Sun from that height. However, the first known claim for the spherical shape of the Earth was made in 600 BC by Pythagoras and then in 350 BC by the Aristotle.

The observations of the Earth from space, as had been narrated by *Sampati* in the *Ramayana*, decidedly show that they had gone up to a handsome height in space because one cannot see very high mountains, such as *Mt Everest, Mount Meru,* so much miniaturized from the ordinary height. However, there is nothing written about the numerical value of height that the J-S brothers had finally attained in their journey into space. This question is very important, and the answer to it can be very valuable information in the history of space exploration done by Indian scholars in ancient times. With such curiosity in mind, the study presented here is an effort to understand the original descriptions of the space journey of *J-S brothers* [8] with the aim to estimate the attained value of height from those textual descriptions. From the Earth, when we observe the Sun, it looks like a disc of apparent size of 15–20 inches hanging like a ball/disc at the observed distance of 1 to 2 km, and the Earth looks too large. This happens due to their different distances from our eyes, and there have been developments of many theories regarding the perception of size and distance based on the relation among apparent size, real size, and distance of objects from the eyes of the observer. Based on these descriptions, it seems that something can be said or inferred about the height of observation of J-S brothers if such points in space from where the Earth and the Sun appear of the same size are located. The main purpose of this paper is to obtain such points above the Earth so that the ultimate height attained by J-S brothers can be estimated. Such expositions will reveal a hidden milestone buried in the path of journey of Indian Knowledge System in the area of space exploration and observation of the Earth from space.

The remainder of this paper is composed of four sections. The next section describes the geometric insights of the observation of the Earth from a height. Section III presents a theoretical formulation for distance estimation under the Earth Centered Inertial (ECI) coordinate system using the distance between the centers of the Sun and Earth. The fourth section presents the results and discussion. Section V presents the conclusions and future studies, which is followed by relevant references gleaned out by us.

Geometry of Observation of the Earth from Space

Nowadays, space technology is highly advanced and has emerged as an interdisciplinary area of research and discovery. Till today, only five countries have landed on the Moon, including India. In the partnership of multiple International Space Agencies, the world has established International Space Stations at an average altitude of 400 km in space from where the Earth and other planets, as well as artificial and natural satellites, are being observed.

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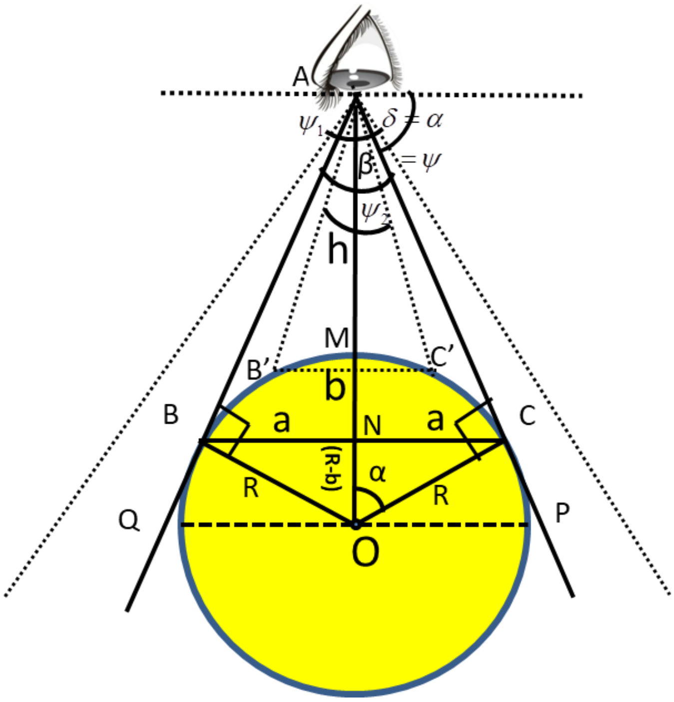

Figure 2. View of sphere of radius R as observed from height h. The spherical cap that is visible from point A with a view angle $\psi=\beta$ is BMC, having height MN=b, tangent AC=AB represents the distance to the horizon, and NC=BN=a is the radius of the base of the visible spherical cap. For the relatively smaller angle of view $\psi<\beta$, a smaller spherical cap *B'MC'* can be seen, however, for the larger angle of view $\psi>\beta$, a larger visible spherical cap can be seen from the same height. The size perception for a large distance depends upon the visual angle β subtended at the eye of the observer.

The basic geometry of observation of spherical-shaped celestial bodies from a distance is interesting, and it is useful here to describe the space odyssey of *J-S brothers* who went up in space to some unknown height, and from there they observed the Earth and the Sun of the same size with their naked eyes. There should be no doubt in the visibility as we can see the Moon and the Sun from the Earth's surface. Let us consider a spherical body of radius R that is being observed from a height h above its surface, as shown in *Figure 2*. The spherical surface is self-hiding, as from any single external point of observation, only half of the surface can be seen maximally. Thus, we always observe only half of the spherical astronomical body if lit properly.

Some important related quantities that can be defined geometrically are described and given below.

From the Geometry of Figure 2, the base of the spherical cap is given by

$$BC = 2a = 2\sqrt{2Rb - b^2} = \sqrt{2h(R-b) - b^2} \quad (1)$$

Also, $cos\,\alpha = \frac{R}{R+h} = \frac{R-b}{R} \Rightarrow b = \frac{hR}{R+h}$ = height of the spherical cap. (2)

The area A_c of the visible spherical cap from height h is given by

$$A_C = 2\pi Rb = 2\pi R\frac{hR}{R+h} = 2\pi R^2\left(1 - \frac{R}{R+h}\right).$$

Hence, the percentage of visible area fraction (VAF) of the half-hemisphere is given by

$$\text{VAF}=\frac{A_C}{4\pi R^2} = 0.5\left(1 - \frac{R}{R+h}\right) \times 100\%. \quad (3)$$

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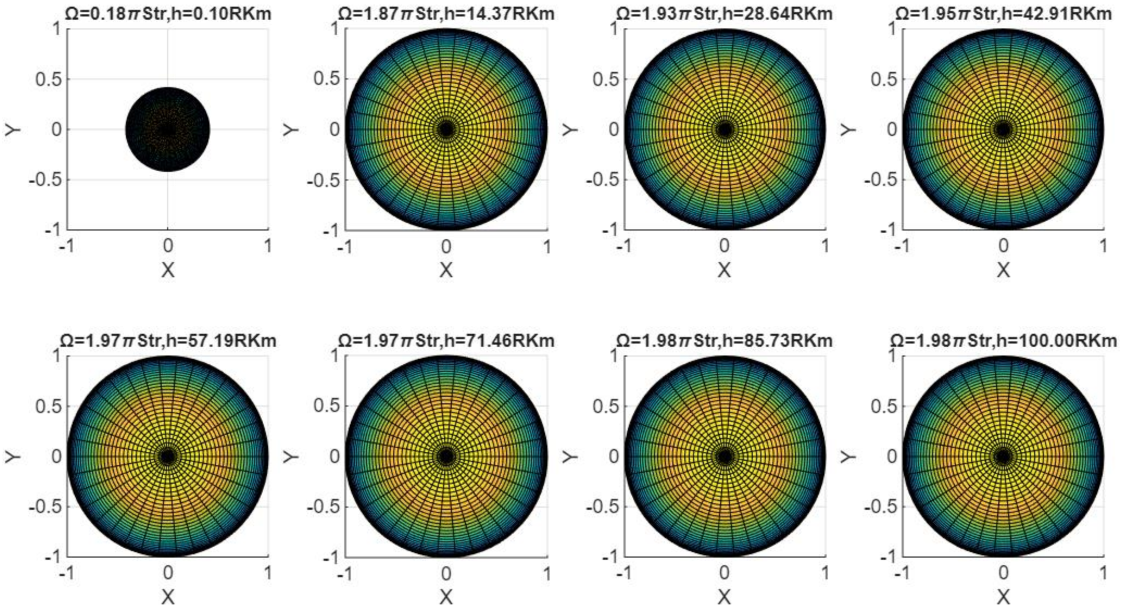

Figure 3. Visible spherical cap area of the sphere of radius R (=1 km) visible from different heights from the surface of the sphere and the solid angle **Ω** subtended by the spherical cap at the center of the sphere. With increasing distance, VAF increases, but the perceived size will decrease.

The maximum distance up to which an observer at height h can see is called the distance to the horizon AC, which can be given as follows, ignoring the effect of atmospheric or terrestrial refraction and other related modifications [16, 17], it can be given as:

$$AC = AB = \sqrt{(2R+h)h} = R\,tan^{-1}\left(\frac{\sqrt{2Rh}}{R}\right), \tag{4}$$

"Dip angle " δ(=α)" in horizon and Solid angle " Ω,"subtended at O by sph.cap, are given by

$$\delta = \cos^{-1}\left(\frac{R}{R+h}\right) = \sqrt{2h/R}\ \ and\ \ \Omega = 2\pi(1-\cos\,\alpha) \tag{5}$$

Obviously, with the increasing height or distance from the surface, one can see a larger area of the spherical planet, and the base of the spherical cap as well as the distance to the horizon will also increase. Thus, as one goes away from the sphere of large radius, like that of the Earth, one cannot see the full sphere even from an infinite distance, but one can see maximally half of the sphere starting from a smaller spherical area. The plots of spherical cap area visible from different heights above the Earth's surface are plotted in *Figure 3*. How much large or small an object appears to a viewer is called perceived size, which differs from its actual size. There have been developments of many theories of visual space description, such as the theory of size distance constancy, used to describe the perception of short-distant objects in visual space, and the theory of retinal image size, used to describe far distant objects in the visual space. The very important parameter used in the description of observation of any object from distance or height is visual angle, which is the angle subtended at the eyes of the observer by the object being viewed. This parameter combines the actual size of the object and its distance from the eyes of the viewer. This also represents the angular size of the image on the retina of the eye and thus is a key factor in solving the distance-size paradox theory. As shown in Figure 4 (a), the visual angle subtended by a linear object of size R from a distance V is given by

$$\beta = 2\,tan^{-1}\left(\frac{x}{V}\right) = 2\,tan^{-1}(R/2V) \tag{6}$$

Where, x = size of object; V = actual distance of object from eye.

For the spherical shape β is also given by

$$\beta = 2\,sin^{-1}\left(\frac{R}{R+V}\right) \tag{7}$$

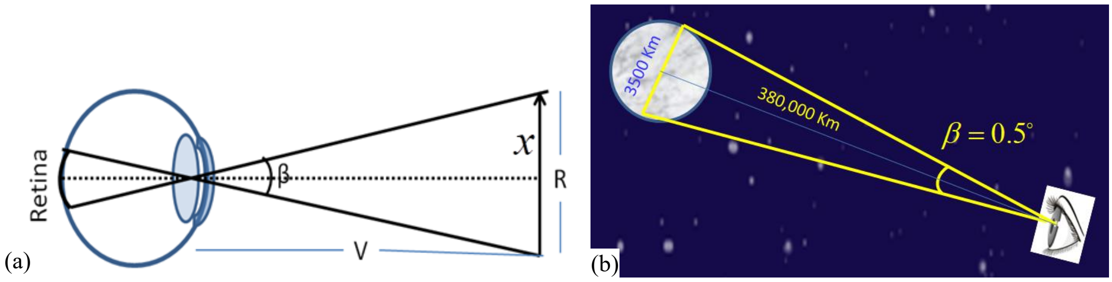

Figure 4. (a) showing the geometry of formation of visual angle at the eyes of the observer (b) Visual angle subtended by the diametric angular arc of the full Moon at the eyes of a observer standing on the surface of the Earth.

Accordingly, as we go up from the Earth's surface towards the Sun, the visual angle subtended by the Earth at the observer's eyes decreases faster, and that subtended by the Sun increases very slowly owing to the vast distance of the Sun from the CoE.

The Moon and the Sun both subtend a visual angle of $\beta \approx 0.5$ degrees, as shown in Figure 4 (b), at the eyes of an observer situated on the surface of the Earth, due to which both the Sun and the Moon appear like discs of almost the same size or circular plates of the same diameter, even though the Sun is many times bigger, approximately 47.6 millions moon can be packed inside the Sun considering Kepler's Conjecture, than the Moon. However, at the eyes of an observer standing on the lunar surface, the visual angle subtended by the Earth's diametric angular arc is 1.7 to 2.0 degrees, so the Earth appears relatively bigger from the surface of the Moon [18]. There have been many developments in theories on the perception of size and distance by the human vision system, but the same for the avian vision system is not fully understood. The in-depth quantitative formulation of our visual space can be found in some relevant research reports [19–23]. Accordingly, at relatively shorter distances, the organism uses other visual cues to perceive size apart from the retinal image, and observation under such conditions is governed by the law of size constancy. On the other extreme, when the object is at a large distance, only the size of the retinal image matters, and other visual cues, such as perceived distance, are ignored. Under such observations, the law of visual angle or retinal image is honored, under which the established fact is that the perceived size of an object is taken as directly proportional to the retinal image size [24]. The visual angle subtended by an object at the eye of the observer depends on its size and distance from the eye, as shown in Figure 5, wherein it can also be seen how objects of different sizes standing at different distances produce retinal images of the same size and are perceived as of the same size like the Sun and the Moon as observed and perceived from the Earth's surface. The theory of visual angles is true for objects at astronomical distances, like the problem addressed here. So, this will be used further here.

In Figure 6 the variation in the visual angle, subtended by diametric angular arc at the eyes of the observer at different distances, is shown for a sphere of unit radius, wherein it can be seen that the visual angle becomes of the order of that of subtended by the Sun at the eye of the observer on the Earth surface (0.5°) when it is observed from a height or distance of more than 200 times its radius. The visual angle provides a clue for the perception of size, but the adequate visibility of the size and shape of objects also depends on the field of view (FoV) of the eye. The FoV was geometrically measured in terms of the angle of view of the eye. With a wider FoV, the entire shape of any object can be observed from a closer distance compared to that with a relatively smaller FoV. The minimum distance/height H_{min} above the surface of a sphere of radius R required to see the entire half sphere with a given angle of view can be expressed as by following equation.

$$H_{min} = \frac{R(1-sin(\psi/2))}{sin(\psi/2)} \tag{8}$$

Where, = Ψ angle of view.

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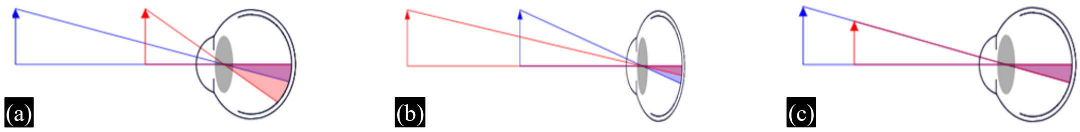

Figure 5. (a) Out of objects of the same size, the nearer object forms a larger retinal image. (b) An object of smaller size nearer to the eye than a distant object of larger size forms a bigger retinal image. (c) An object of different sizes placed at different distances from the eyes may also form a retinal image of the same size.

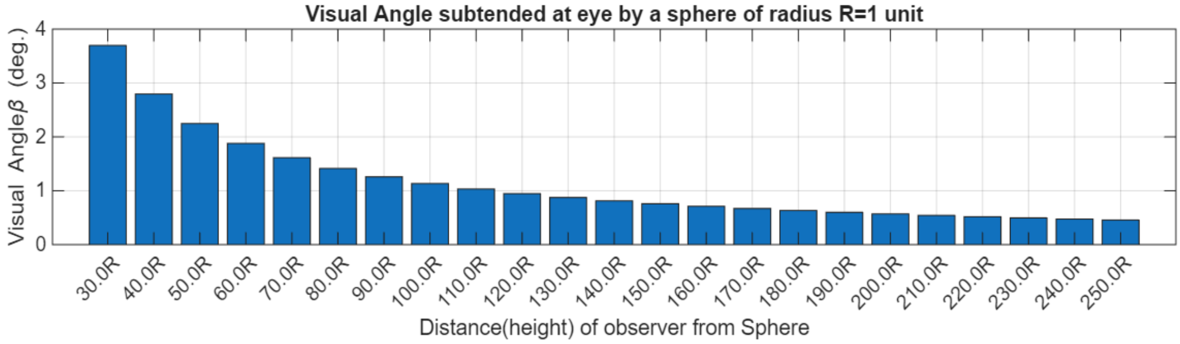

Figure 6. Visual angle β subtended by a sphere of unit radius at different heights/distances proportional to its radius.

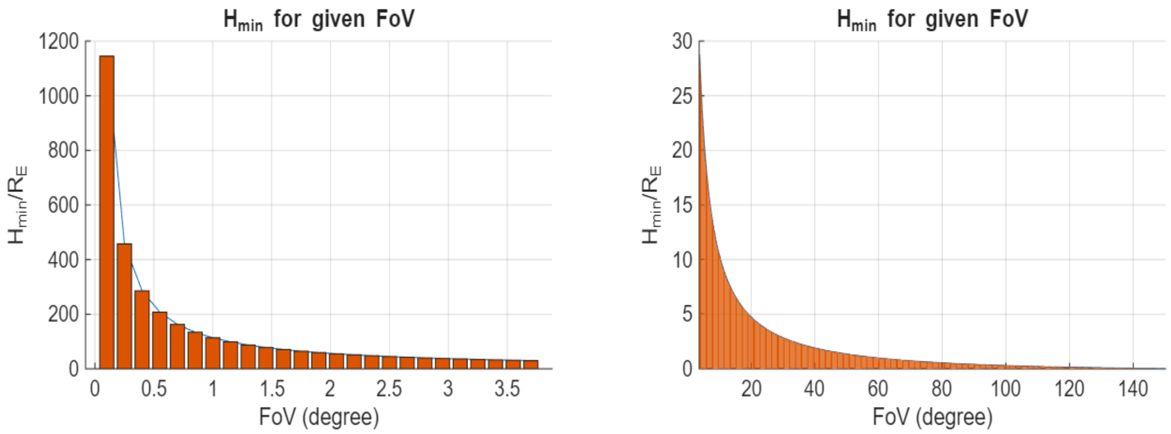

Figure 7. Showing the minimum height required from the surface of the Earth to see the whole disc of the Earth for the given angle of view.

The plot of Equation (8) is shown in Figure 7 for different values of the viewing angle and the corresponding minimum height at which an observer is required to see the full half of the spherical shape. It is also evident that for a given larger value of FoV, the required minimum height is reduced. The visual angle subtended at the eyes of the observer by the object at minimum height H can be taken equal to the angle of view as Ψ.

It is interesting to observe here in Figures 6 and 7 that the increasing height of the observer makes the visual angle to decrease, and for the given viewing angle, the covered ground distance/area in a glance increases. The FoV for the *Jatayu's* eye can be compared to modern results and it can be assumed to be more than 150 deg and with such a large FoV one needs to be at the altitude of more than 200 km above to see the whole Earth as a circular disc, however, at such distance the Earth will look much bigger than the Sun because the visual angle subtended by the Earth is large. Obviously, for the larger viewing angle, the whole spherical curvature becomes visible from a relatively shorter distance, but the visual angle remains larger, due to which the Earth disc will look bigger [25]. The problem addressed

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in this paper is based on the space odyssey of two vulture brothers having genetic lineage with the *Garuda* or Eagle family, as has been described in the epic *Ramayana* [8]. A full knowledge of the avian vision system, its function, and perception mechanism, etc., is required here, which is still unexplored. It was found long ago that birds have distinguished features of retinal specialization that ensure high resolution over a larger area of retina. Birds like hawks, eagles, vultures, and kingfishers have very high cell density in the retina with a well-developed high acuity pit called the fovea [26–28]. The functioning of the vision systems of birds has a bundle of associations and dissociations with that of the human vision system; however, the physics of the formation of the retinal image is also same, and the basic structure of the eyes is the same. But the process of processing, representation, and understanding of visual signals may be different. The vision systems in birds are tetra-chromatic as they can see four basic colors, namely red, blue, green, and UV, while our vision system is trichromatic. However, the visual perception and learning process in avians is quite complex and less understood so far [29]. Vultures and eagles are known for sight, flight, and might, and have exceptionally keen eyesight due to unique retinal adaptations that enhance their vision, particularly for spotting carrion from great distances. They have high visual acuity due to the availability of a high density of photoreceptor cells, allowing them to see fine details at long ranges. This helps them to judge distances more accurately, especially when hunting or navigating. They are believed to have excellent color vision with the ability to see ultraviolet light, which helps them to distinguish between different types of food and environmental cues. The placements of their eyes are such that they get a broad field of vision, and by moving their head, they produce changes in perspectives which are crucial for spotting food while soaring at high altitudes. The retinal structure supports their ability to fly long distances without tiring, as they often cover very large areas [12] in search of food. These adaptive abilities make vultures highly effective scavengers in their ecosystems. It is also interesting to note the conclusions of research reported in a study [30] that the vultures fly at high altitude where there is tension of oxygen, but the biological structure of their retina shows enhanced lactic dehydrogenase (LDH) activity in all layers of retina, which is suggestive of the fact that the anaerobic glycolysis provides energy to the retina and helps oxidation of Vitamin A. Such superiority of neurobiological functions in the eyes supports the high-altitude flight of the vulture. One of the very important investigations has been reported in a study [21] in which retinal image size difference has been taken as a very important cue for recognizing physical features such as shape, color, pattern, binocular disparity, and size of objects involving the role of the V4 area of the visual cortex in monkeys. It has been found that these cells are very smart and react differently to the farther and nearer position of the object in an adapted manner to decide the shape and size of the object from the retinal image, meaning thereby it acts on true object size. The birds have bigger and better V4-like functional areas in the form of the tectofugal system [22] for the visual motion processing, and it hints at the existence of a somewhat similar mechanism of size and distance perceptions. The actual anatomy and functioning of the vision system of *J-S brothers* is not available, but the available textual descriptions in the said epic [8] establishes their unique abilities for long-distance sight, heroic might, and flight. The problem addressed here requires a clear-cut explanation and models for the perception of size and distance by an avian vision system, but the understanding of the same is still vague and unknown. As stated above, many experiments for the perception of size and distance have been done on the human vision system, where, for very large distances, the vision theory of retinal image size has been found valid [24, 31, 32]. Hence, we assume here that the process of the size and distance perception in the avian vision system is geometrically similar to that of humans [33], and in the next section, such assumptions will be used to estimate the height of observation of J-S brothers in their space journey. However, the visual spaces for birds in general and humans are different and are superior for birds. Research studies in these directions are also underway which may expose the truth and reveal realities [34].

Height of Flight of J-S Brothers in Space

Using the concept of visual angle, the height attained by the *J-S brothers* can be estimated here. As stated in the epic *Ramayana*, the J-S brothers went up to a height from where the size of the Earth and

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the Sun appeared to them the same, as depicted in Figure 1, which in turn means that the values of visual angles subtended at the eyes of the J-S brothers at that height by the Earth and the Sun were the same. Let us consider that the J-S brothers went towards the Sun following the line joining the center of the Earth and that of the Sun [8]. The plot of subtended visual angles at the eyes of J-S brothers at different heights is shown in Figure 8, from where one can infer that the visual angles subtended by the Earth go on decreasing and that of the Sun suffers a negligible increment or remains almost constant because the distance between the Sun and the Earth is very large. There can be space for approximately 107 Suns or approximately 11686 Earths between the Earth and the Sun along their central line. However, as we go away from the Earth's surface towards the Sun, the visual angle subtended by the Earth decreases, and that of the Sun increases [35]. So, between the Sun and the Earth, it is possible to attain a height at which the Sun and the Earth will subtend equal visual angle, and from that point their perceived sizes will also be equal. Such a situation is shown in *Figure* 9, in which observer *Jatayu* is at *J* at height/distance *H* from the Earth, from where the base of the visible spherical cap is given by Equation (1), and at the same point, the visual angle subtended by the Sun is say β_s. Now, if we place an object of the size of the base of a visible spherical cap of the Earth between the Sun and observer J, say at some certain distance *h*, it will subtend a visual angle equal to that of subtended by the Sun, and both will be observed as of the same size. If the same is placed before the position of AM, the visual angle will be larger than β_s and for the position beyond AM, the visual angle will be less than β_s [34]. In fact, the visible spherical cap area for every height from the surface of the Earth will get a unique position, like AM, from where it will subtend a visual angle equal to β_s as shown in Figure 9, where both visual angles are equal. Thus, with a certain view angle, say Ψ, if one starts to go away from the Earth, the viewer will be able to grasp the whole half of the Earth from a height H_{min} given by Equation (8). At some point, viewing angle and visual angle will be equal, and beyond that, the increase in viewer's distance will decrease the visual angle further, and at some height, visual angle will be equal to that of the subtended by the Sun from where the Earth and the Sun will be perceived as the same size [36]. As the distance between the Sun and the Earth is huge, the change in visual angle β_s will be felt as negligible, as is shown in Figure 8. Assuming the horizon line to be tangential to the visible spherical cap of the Earth, the height of J-S brothers from the center of the Earth (CoE) can be obtained from the geometry of Figure 4 and can be given by

$$H_{JS} = \frac{\sqrt{2R_E b - b^2}}{sin\left(\frac{\beta_S}{2}\right)} = \frac{R_E}{sin\left(\frac{\beta_S}{2}\right)} \quad (9)$$

where, β_s is in radian

The visible portion of the spherical cap of the Earth that can subtend a visual angle of $\beta_E \approx 0.5°$ can be seen from a height greater than $212R_E$ From such a greater height, almost half of the Earth will also become visible.

The visual angles subtended by the Earth and the Sun at the Eyes of *J-S brothers* with their increasing height from the Earth's surface are plotted in Figure 8, which clearly shows that both visual angles β_s and β_e are equal for the height of about $212R_E$ and from that height, the Sun and the Earth will be perceived as of the same size. As said before, the visible surface area, also known as the spherical cap visible from different heights above the Earth's surface, increases with increasing height and assumes a maximum value of base length which approaches 2R at the heights of more than $212R_E$. As we go up from the Earth's surface, the visual angle subtended by the Earth decreases, as shown in Figure 9, wherein it can also be seen that the visual angle of the Earth goes to the order of that of the Sun when it is observed from a height of 210–216 times the radius of the Earth [37]. Thus, the height estimated geometrically from Equation (9) is free from the distance-size paradox.

As the Earth is spherical in shape and is revolving around the Sun, geometrically, there can be many such points in every radial direction from the Earth's surface from where the Sun and the Earth can be observed of the same size due to equality in the visual angle subtended by them.

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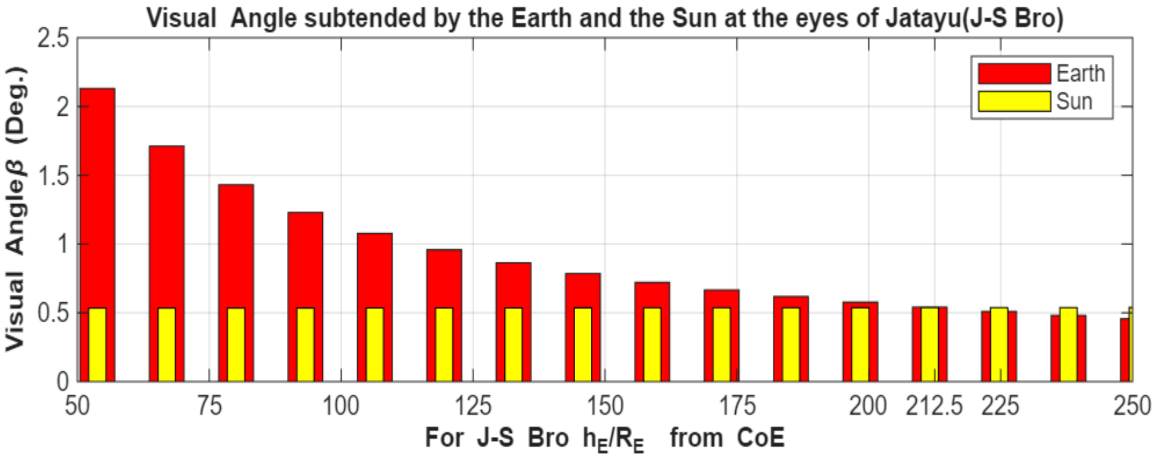

Figure 8. This figure plots the visual angle subtended by the Earth as a function of the h/R ratio. It is obvious from here that the change in visual angle of the Sun is negligible, so the perceived size of the Sun will not change significantly even at a height of more than 212 R_E but that of the Earth changes swiftly.

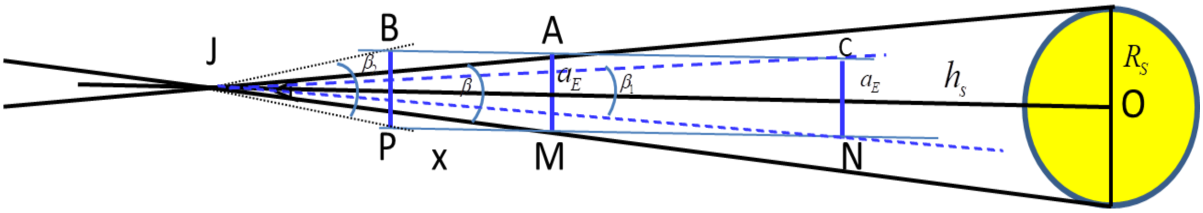

Figure 9. Showing how the Earth and the Sun can be observed as of equal size from point J in space. Length AM of the spherical cap base of the Earth visible from height h gets a single position between the Sun and the Earth, from where it subtends a visual angle β_s. For a position, say BP, its visual angle β_1 is greater, and for position CN, its visual angle β_2 is smaller than β_s.

In order to calculate the locations of all such points, let us consider that the Earth and the Sun are fully spherical in shape and imagine a spherical coordinate system placing its origin at the CoE, as shown in Figure 10. Let us consider that such an Earth centered inertial (ECI) frame with origin at the center of mass of the Earth at O and x-axis OX in the direction of vernal equinox and z-axis OZ in the direction of celestial north and y-axis OY in the ecliptic plane, such that perpendicular to OX and OZ axes. The ECI coordinate system is a non-rotating frame and is fixed at the CoE [38]. This frame is suitable for the mathematical formulation of the problem addressed in this paper, which requires a description of the position of the Sun and J-S brothers, shown as J for convenience in Figure 10.

Let the spherical coordinates of *J-S Brothers* and the Sun be (r_1,θ_1,φ_1) *and* (r_2,θ_2,φ_2) respectively, as shown in Figure 10, for which the Cartesian coordinate conversion is performed using Equation (10), as follows:

$$x_m = r_m \sin\theta_m \cos\varphi_m = r_m \cos(90-\theta_m)\cos\varphi_m, \tag{10}$$
$$y_m = r_m \cos\theta_m \cos\varphi_m = r_m \cos(90-\theta_m)\cos\varphi_m,$$
$$z_m = r_m \cos\theta_m,$$

where,

m=1 for the coordinates of J-S brothers and 2 for the coordinates of the Sun.

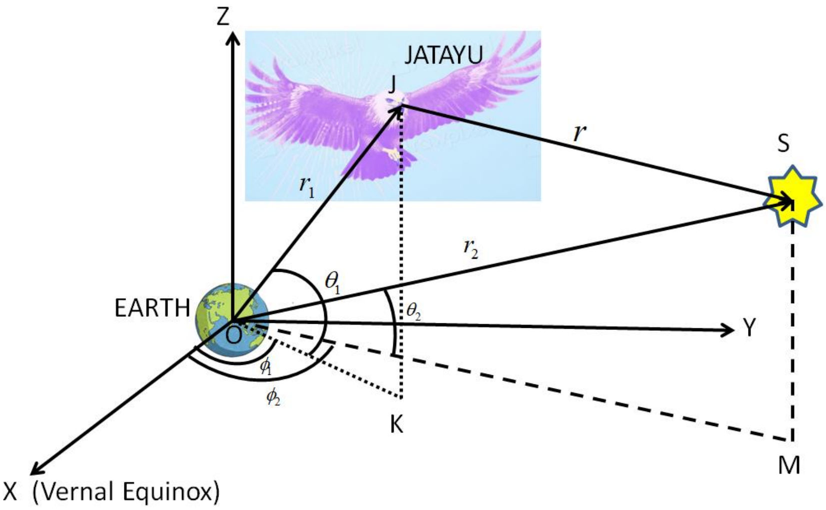

Figure 10. ECI Coordinate System for localization of the Sun and the J-S brothers as a satellite. For convenience, J-S brothers are shown by a bird's picture.

For simplicity, the J-S brothers have been assigned the same coordinates here, but as mentioned in the epic *Ramayana*, the younger brother *Jatayu* went higher than the elder brother *Sampati,* who first went ahead. From the geometry of Figure 10, the distance r between the Sun and *Jatayu* can be expressed as follows:

$$r = \|r_1 - r_2\| = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2} \tag{11}$$

Which can be reduced to the following equation using values of Cartesian coordinates from equation 11.

$$r = \sqrt{r_1^2 + r_2^2 - 2r_1 r_2 f(\theta, \varphi)} \tag{12}$$

$$f(\theta, \varphi) = \sin\theta_1 \sin\theta_2 \cos(\varphi_1 - \varphi_2) + \cos\theta_1 \cos\theta_2$$

$$f(\theta, \varphi) = \cos(90 - \theta_1) \cos(90 - \theta_2) \cos(\varphi_1 - \varphi_2) + \sin(90 - \theta_1) \sin(90 - \theta_2).$$

According to the theory of visual perception [24], the realization of physical size and distance is subjective, and the relationship between the perceived size δ, visual angle β, and perceived distance d is expressed as $\delta=\beta.d$, which can be used to describe the observance from the J-S point to obtain

$$\delta_s = \beta_s \,.\, d_s \text{ and } \delta_E = \beta_E \,.\, d_E \text{ and at the J-S point } \beta_s \,.\, d_s = \beta_E \,.\, d_E \tag{13}$$

where,
$\beta S(\beta E)$=visual angle subtended by the Sun(Earth),
$dS(dE)$=perceived distance of the Sun (Earth),
$\delta S(\delta E)$=perceived size of the Sun(Earth).

Accordingly, the perceived distances of the Sun and the Earth are given by

$$\frac{d_S}{D_S} = \frac{A_S}{A_S + D_S} \quad and \quad \frac{d_E}{D_E} = \frac{A_E}{A_E + D_E}, \tag{14}$$

where,
$A_{S(E)}$ = Apparent distance of the Sun (Earth) to observe.
$D_{S(E)}$ = Physical distance of the Sun (Earth) from observer.

Using Equation (14) in Equation (13) gives

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$$D_S = M + ND_E \Rightarrow r = M + Nr_1 \tag{15}$$

where $M = (k-1)A_S$ & $N = k\left(\frac{A_S}{A_E}\right)r_1$ & $k = \left(\frac{R_S}{R_E}\right)$.

Using Equation (15) in Equation (12), the following quadratic equation is obtained for r_1

$$(N_2 - 1)r_1^2 + [2MN + 2r_2 f(\theta,\varphi)]r_1 + (M^2 - r_2^2) = 0 \tag{16}$$

As discussed before, the retinal image size, measured in terms of the visual angle *β,* of the object is a valid measure for the distance-size perception of objects at an astronomical scale. Assuming that *Jatayu* observed both the Sun and the Earth in full from their position, the visual angles β_e and β_s, subtended by the diametric angular arc of the spherical cap of the Earth and the Sun, respectively, at the eyes of *Jatayu* (say), as shown in Figure 11, can be given by

$$\beta_e = 2\,tan^{-1}\left(\frac{R_E}{H_E}\right) = 2\,tan^{-1}\left(\frac{R_E}{r_1}\right) \text{ and } \beta_s = 2\,tan^{-1}\left(\frac{R_S}{H_S}\right) = 2\,tan^{-1}\left(\frac{R_S}{r}\right) \tag{17}$$

where R_E and R_s are the radii of the Earth and Sun, respectively

Let us also assume that the J-S brothers are at a position from where they observed that the size of the Sun and that of the Earth were equal. Under such conditions, we assume that the retinal images of the Sun and Earth are of the same size under the visual angle-based perception of size in a visual space, and that the use of Equation (17) yields.

$$\beta_e = \beta_s \Rightarrow \left(\frac{R_E}{H_E}\right) = \left(\frac{R_S}{H_S}\right)$$

$$\Rightarrow \left(\frac{H_S}{H_E}\right) = \left(\frac{R_S}{R_E}\right) \Rightarrow r = \left(\frac{R_S}{R_E}\right)r_1 = kr_1. \tag{18}$$

Under such conditions, the quadratic Equation (16) for r_1 can be expressed as follows:

$$(k^2 - 1){r_1}^2 + 2r_2 f(\theta,\phi)r_1 - r_2^2 = 0 \tag{19}$$

The solution of this quadratic equation gives

$$r_1 = \frac{-r_2 f(\theta,\phi) \pm r_2\sqrt{f^2(\theta,\phi) + k^2 - 1}}{(k^2-1)} \tag{20}$$

These two values, r_{1A} and r_{1B} of r_1 are complementary to each other in the sense that they lie around the Earth in opposite locations to each other but at different distances. These are points at which the Earth and the Sun subtend equal visual angles in the eyes of a positioned observer, which means that from there, the Earth and the Sun will appear as a circular disc of the same size. The locus of these points of similarity is similar to that of the Apollonius circle [35].

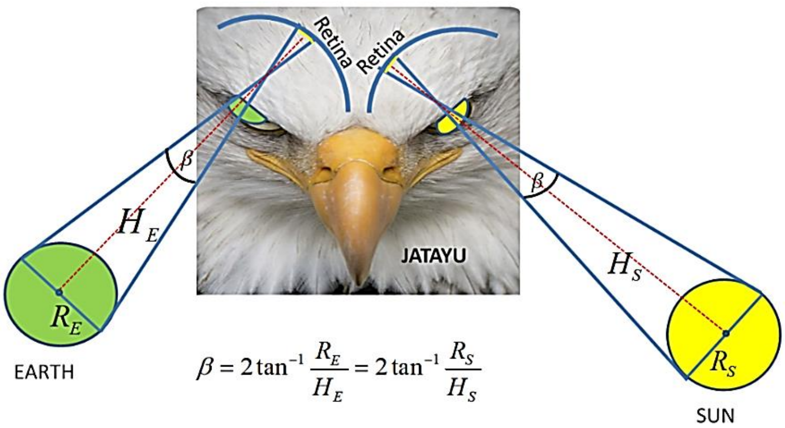

Figure 11. Observation of the Earth and the Sun by *J-S* brother *from the height H_E.*

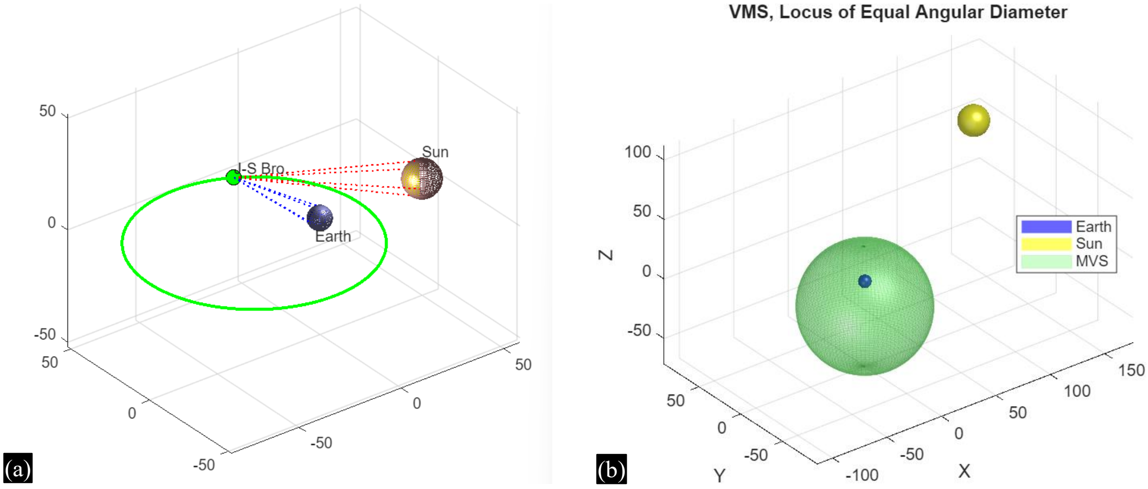

Figure 12. Showing the position of J-S brothers, the Sun, and the Earth on scaled-down distances to demonstrate observation of the Sun and the Earth from two opposite positions around the Earth.

This means that the J-S brothers went up to which of any of such points that cannot be ascertained, however, the textual descriptions say that they went directly towards the Sun. Let us call these points *Jatayu-Sampati points or J-S points, as shown in Figure 12* in deep space, in honor of the J-S brothers, one of the most ancient astronauts of India. The locus of all such J-S points is a sphere with its center on the line joining the centers of the Earth and the Sun. Let us call or propose name of this sphere as the *Maharshi Valmiki Sphere (MVS),* in the honour of *Maharshi Valmik* who gave this astronomical idea before 5000 BC. The center of the proposed MVS can be estimated by averaging r_{1A} and r_{1B} and its distance from the CoE can also be calculated.

RESULTS AND DISCUSSION

In this section, some results based on the aforementioned theoretical descriptions are presented for the space flight of the J-S brothers obtained to verify the textual description as presented in the great epic, the *Ramayana.* The main aim of the present investigation was to estimate the position of J-S brothers based on textual descriptions and the position of the Earth and the Sun. As per Equation (7), the visual angle subtended at the eyes of *J-S brothers* (take one of them, say *Jatayu*) by the Earth will decrease, and that of by the Sun will increase slightly with increasing distance from the Earth, and at a certain height, both visual angles β_s and β_E will be equal. Such points in the space will be the point of similitude from where the observer will perceive the Sun and the Earth of equal size. The plots of these two visual angles β_e and β_s as functions of height from the Earth are shown in Figure 13. It is obvious that the heights lying between $200R_E$ and $216R_E$ are very important range of heights wherein these angles become very near to each other, and at a distance $h_{js} \approx 212.75R_E$, both visual angles are exactly equal. This is also in conformity with the estimated distance as per Equation (9). However, such an enormous distance represents a location in deep space near the outer limit of the Hill sphere of the Earth. Obviously, to see the Earth and the Sun at equal visual angle, one needs to go away from the CoE at a distance in the range of $212R_E$ to $213R_E$ units and such points can be in plural numbers around the Earth. The visual angles at this point come to $\beta_s = 0.5378$ and $\beta_E = 0.5417$ which gives the height of J-S brothers 1.35×10^6 km and 1.34×10^6 km respectively.

So, it is important to know if there is that much separation or space for an observer following the line that joins the centers of the Earth and the Sun. The average distance between the Sun and the Earth is 1 A.U., which is a very large separation and is more than enough to accommodate the distance of more than $200R_E$ from the Earth and $213R_E$ from the Sun in a line, as can be seen in Figure 14, which plots H_S/R_S vs H_E/R_E positions of the observer (J-S brothers). It is obvious from there that the observer can take a position from where the Sun and the Earth can be observed at equal visual angles. This is interesting because the Sun is much bigger than the Earth and thus $213R_s >> 213R_E$ but the beauty of

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the divine setup is such that it is fit to accommodate so. It is important to observe in Figures 13 and 14 together that the observer at a height between $212R_E$ and $213R_E$, Also gets a window of visual angle between 0.53–0.54 degrees for both the Sun and the Earth, which ensures equality in their perceived size.

As per Equation (1) and Equation (3), it is obvious that one cannot see the whole sphere of the Earth, the Moon, or the Sun from any distance, as they have self-hiding shapes. Maximally, one can see half surface area of any spherical shape from a very large distance. Such a plot is shown in Figure 15, which shows the required height to see the full half surface area of the spherical shape. The curve becomes asymptotic for 50% visible area, which means from an infinite distance one can see half of the sphere, however, it can be said that the height from where the J-S brothers observed the Sun and the Earth was enough to observe almost the full discs of the Earth and the Sun.

The estimation of the height of J-S brothers under the setup of ECI coordinates using Equation (16) requires the use of planet ephemeris data to know the position of the Earth and the Sun. Nowadays, the planet ephemeris data are stored as Chebyshev polynomial coefficients fit in 32-day-long segments, which are available in the MATLAB package too. The computation of the height of J-S brothers, as proposed before, requires information such as the distance between the Sun and the Earth and the position of the Earth. The average distance between the Sun and the Earth is remarkably constant. The Earth's orbital path experiences slight predictable changes over thousands of years, which affect the exact distance at any given time.

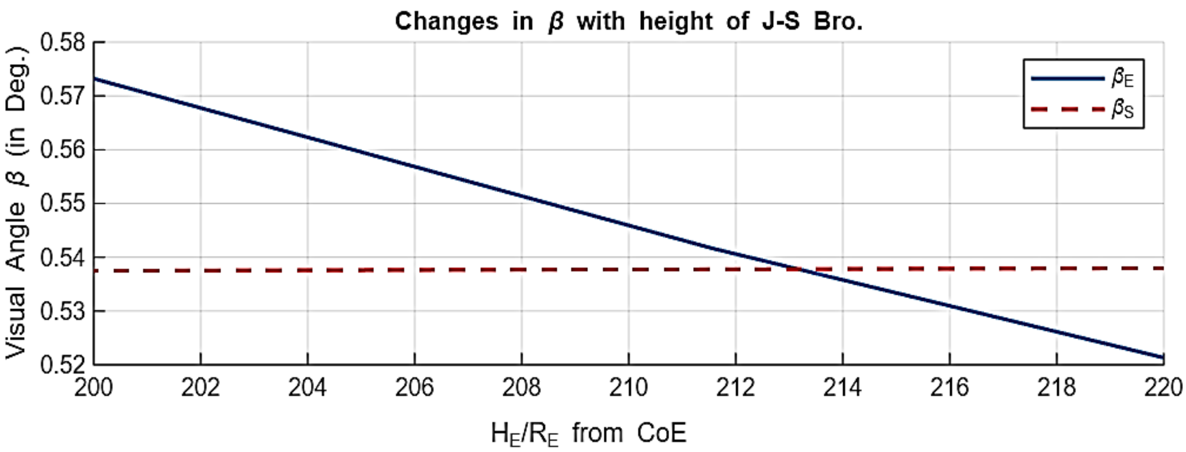

Figure 13. Visual angles subtended by the Earth and the Sun at the eyes of observers moving up towards the Sun from the Earth. At a distance of $212R_E$ to $213R_E$ from CoE, their visual angles become almost equal.

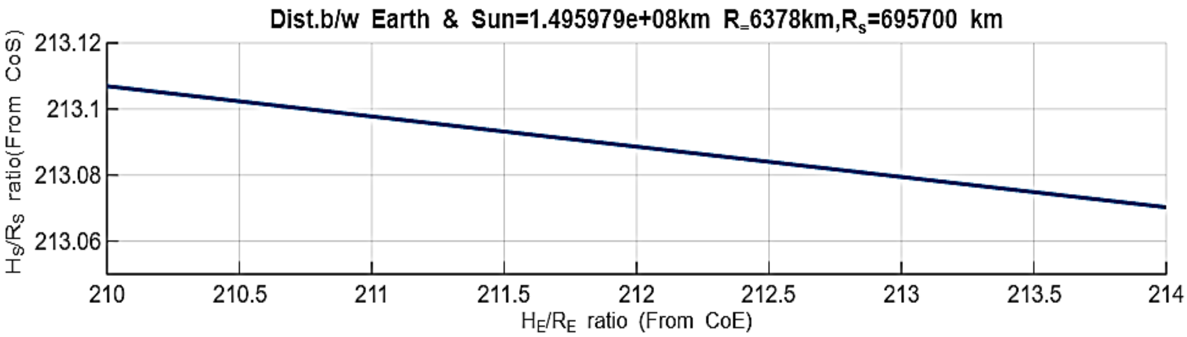

Figure 14. Even if an observer goes up to $213R_E$, the distance of the observer from the Sun, the distance remains enough to maintain a visual angle of 0.5 degrees for their equal size perception, and distances from the Sun and the Earth are accommodable between the Sun and the Earth.

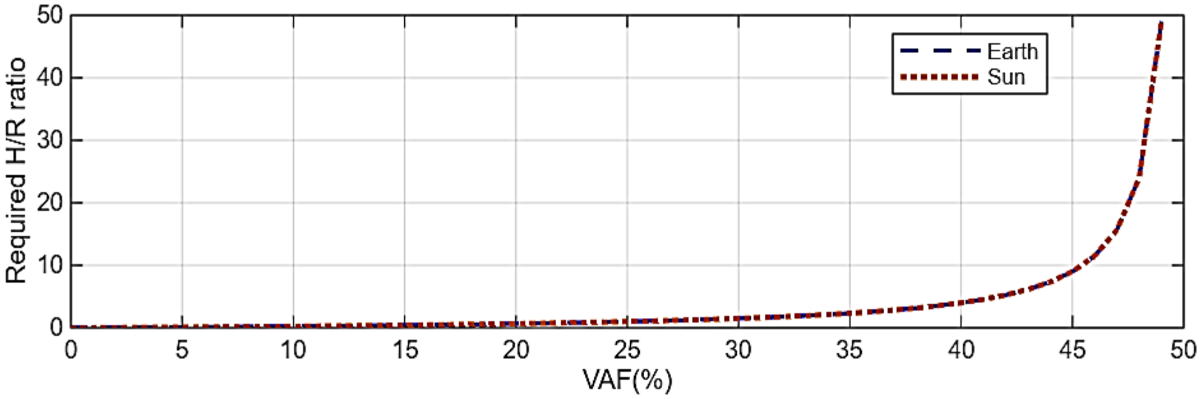

Figure 15. The height-to-radius (H/R) ratio required to see a certain percentage of a spherical cap. The curve near 50% becomes asymptotic, which indicates that the full percentage of a half-spherical cap can only be seen from infinity, i.e., from a very large distance.

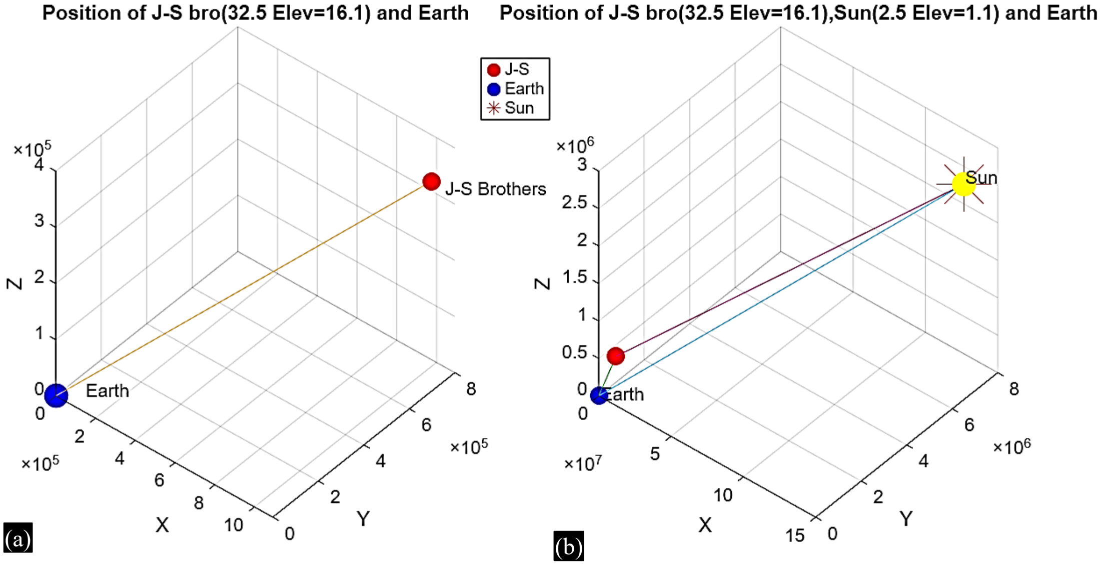

Figure 16. (a) The ECI positions of J-S brothers as estimated using Equation (13) for the shown azimuth and elevation. (b) ECI Locations of the Earth, the Sun, and J-S brothers in space for the shown azimuth and elevation.

There are many minor long term changes in the Earth's orbit, such as Milankovitch cycles which include changes in the eccentricity of the orbit over a period of 100,000 years, changes in axial tilt over the cycle of 41,000 years, precession in rotational axis due to wobbling of the Earth over the cycle of 26000 years etc., however, these all do not change average distance between the Earth and the Sun [39]. So, the height of J-S points will not change even if estimated in the current date or in the period of the actual journey of the Ramayan period. Thus, it was chosen to use ECI coordinates-based estimation of the height of the J-S brother using planetary Ephemerides data such as DE 430, covering years 1550 to 2650, for the current time. In Figure 16, the location of J-S brothers obtained using estimated spherical coordinates of the Sun and Earth as per Equation (20) is shown with and without the location of the Sun. The ECI coordinates were computed using ephemeris data DE430 in MATLAB. The estimated distance of J-S brothers from the CoE is in the order of 10^6 km ($\approx 1.3\times10^6$ km) which is in the unstable region of deep space. It was shown before how the visual angles become equal for the observer at this height. From such a large distance, the Moon and Earth will look in one visual space, and they can be seen at a glance. The Moon will look like a smaller spot. The absence of atmosphere will make the sky black, and the Sun will look like a terrifying, bright circular disc in the pitch-black background, surrounded by un-twinkling stars.

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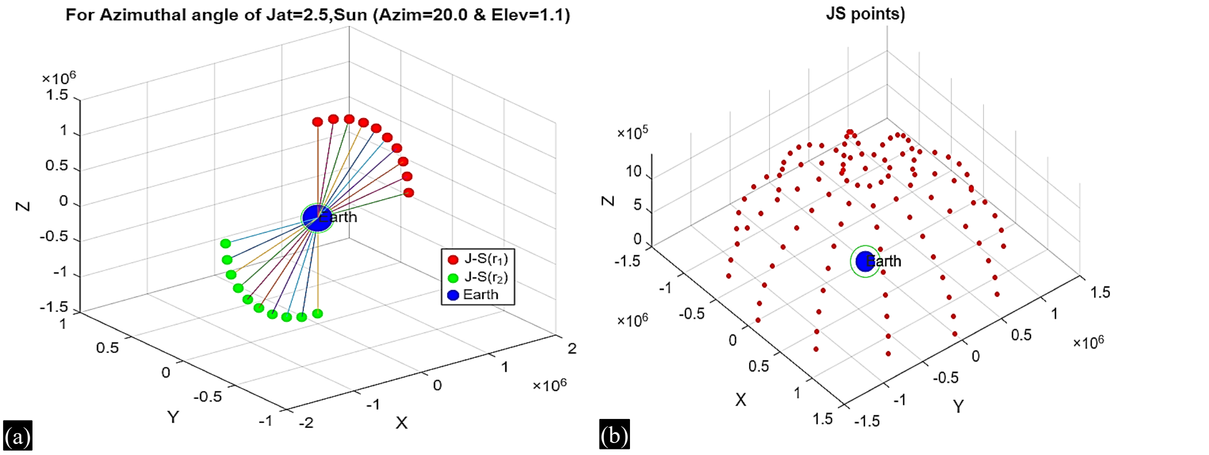

Figure 17. (a) shows the locations of *J-S points* around the Earth as estimated using Equation (18). (b) Different J-S points are distributed on the spherical surface, *proposed to call here as Maharshi Valmiki Sphere (MVS)*, around the Earth, as shown for half of the Earth. The center of this sphere was estimated at a distance of 12727 km from the center of the Earth on the line joining CoE and CoS.

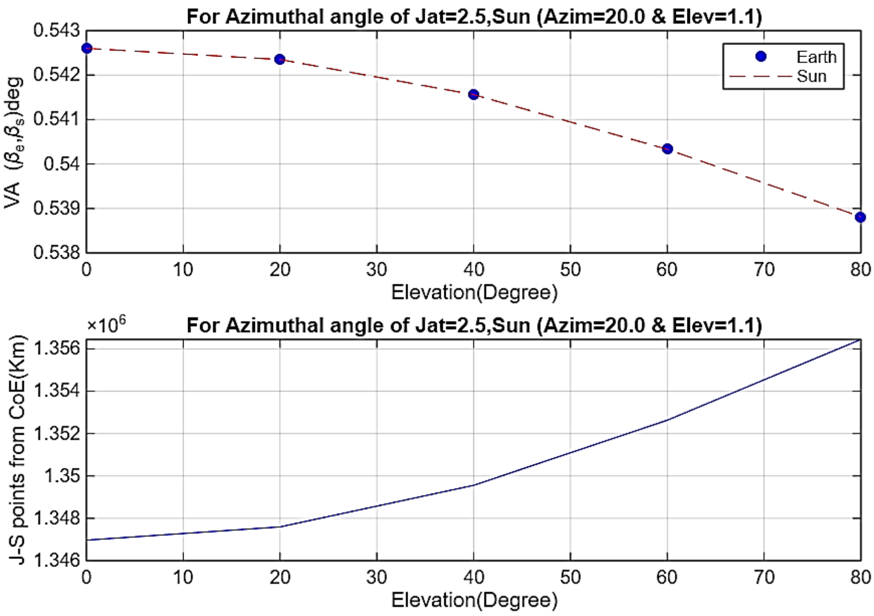

Figure 18. The visual angles subtended by the Earth and the Sun at the J-S points and corresponding distances from CoE.

It is obvious from Equation (20) that the two solution points for J-S brothers for the given elevation and azimuth of the Sun are in a radial direction but opposite to each other. Distribution of such points around the Earth for the different elevation and azimuth angles is shown in Figure 17. The estimated values of visual angles subtended at the observer at these points are shown in Figure 18, where it can also be observed that the visual angles remain the same and thus the Sun and the Earth will appear of the same size if observed from these points. It can also be observed from there that the heights of J-S points are in the order of 10^6 km from the CoE. Thus, the height of J-S brothers estimated from Equation (9) and Equation (20) agrees. However, it can be observed in Figure 18 that the change in visual angle subtended by the Sun at the estimated height is negligible because of the very large distance between the CoE and center of Sun (CoS). At the estimated heights of J-S brothers, the value of the visual angle subtended by the Sun is $\beta_s \approx 0.538$ and at the surface of the Earth $\beta_s \approx 0.533$, which makes an unperceivable change, barely by 0.9%, in the apparent size of the Sun. In *Figure 19*, the visual angles β_s and β_E are shown for different values of φ_1 and θ_1 for the fixed positions of the Sun.

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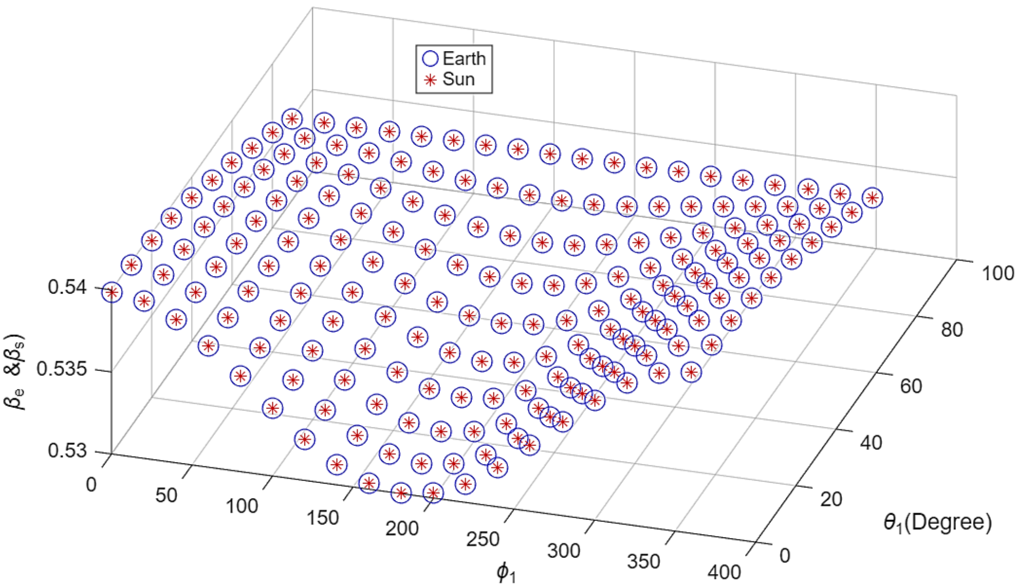

Figure 19. Shows visual angles subtended by the Earth and the Sun at different J-S points for different Elevation (θ) and Azimuth (φ), wherein their equalities can be observed, which ensure equal sized perception of the Sun and the Earth.

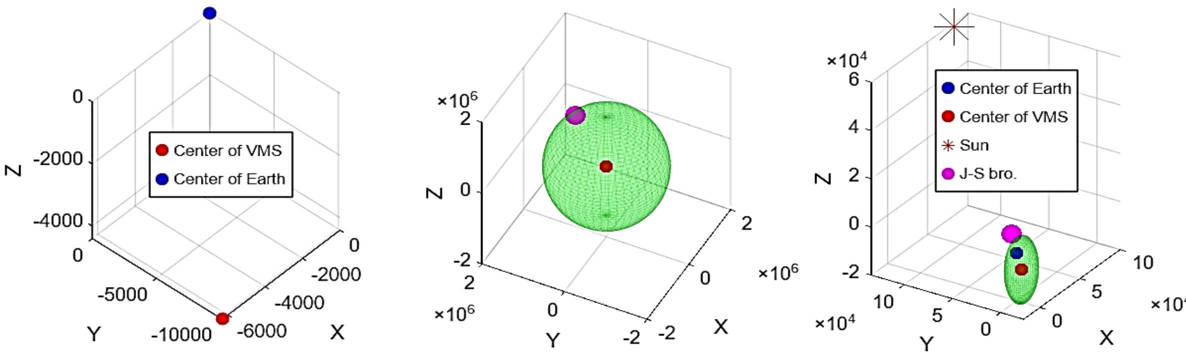

Figure 20. The first figure shows the estimated centers of MVS and CoE, the middle figure shows the spherical locus of J-S points on the Valmiki Sphere, and the rightmost figure shows all together with the Sun; however, the radius of MVS and the distance of the Sun have been scaled down by 100 and 50, respectively, to keep these things visible together.

It can be observed from there that these visual angles are the same for all those locations of similitude. As per Equation (18), the two values r_{1A} and r_{1B} of r_1 are not equal, which gives the center of MVS shifted from the CoE by a calculable distance of 12727 km on the line joining the centers of the Earth and the Sun. This is shown in *Figure 20*, where, in the rightmost figure, the distance of the Sun and the radius of the MVS have been scaled down to keep clarity in the representation. The MVC represents locations of all J-S points from where the Sun and the Earth can be perceived as of equal size.

The variation in estimated distance as per Equation (20) for different elevations and azimuths of J-S locations is shown in Figure 21, wherein it can be observed that the increasing elevation and azimuth angle increase the height of J-S points for the given position of the Sun. However, J-S brothers went to which J-S point cannot be said here, but it is stated in the epic *Ramayana* that they took off from the peak of the *Kailash* Mountain and flew towards the Sun.

The space journey of J-S brothers was simulated in MATLAB's satellite scenario object to see the portion of the Earth covered from these heights. In that scenario, J-S brothers were taken as the satellite and a camera was attached to the satellite, as shown in Figure 22 by tag *J-S bro*. The satellite camera's

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instantaneous view of the Earth's surface depends on altitude, the FoV of the camera, and consideration of sunlit surface area or geometric cap area, which appears as the circular patch known as the footprint. With the decreasing FoV, the footprint area becomes smaller than the geometric cap area. For different viewing angles, the portion of the Earth that can be scanned was recorded. The related screenshots of the Earth for different viewing angles are shown and depicted in Figure 22. The simulation results show that with the greater viewing angles, the whole half of the Earth can be seen from a smaller height, but with a viewing angle of 0.5 degrees, making equal to visual angle subtended by the Sun, one needs to go up to heights in the order of 10^6 *km* above the ground.

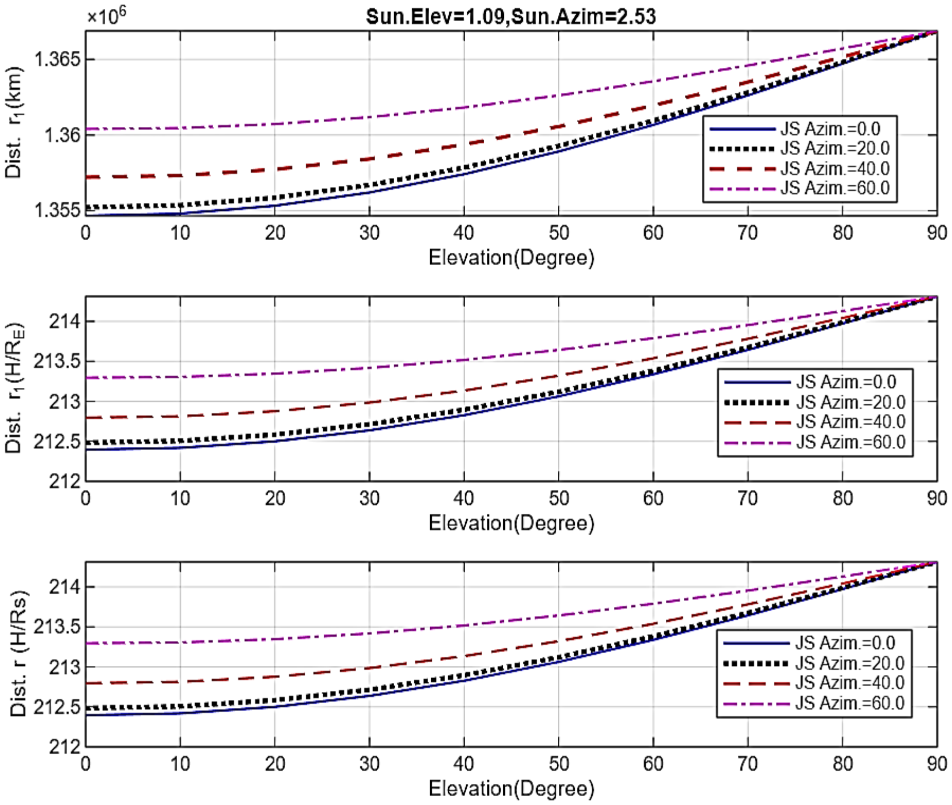

Figure 21. Estimated distance of J-S points from the centers of the Earth and the Sun using Equation (18) and h/R ratio for distance from the CoE and CoS for different elevation (θ) and azimuth (φ).

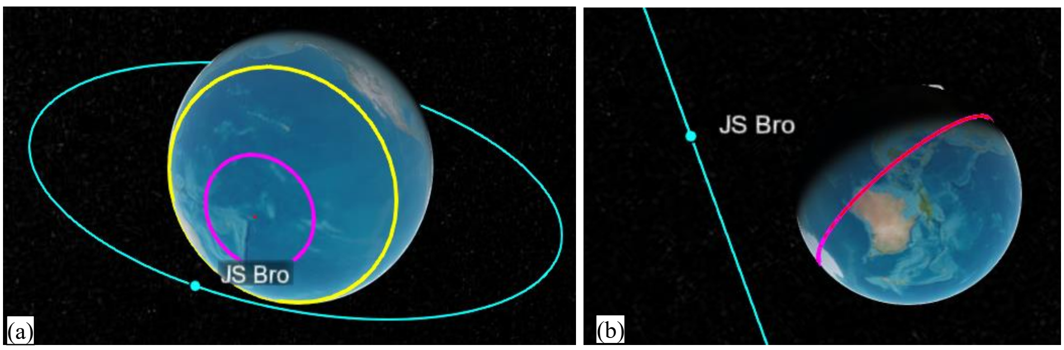

Figure 22. Screenshot of simulation done in MATLAB for the position of J-S Bro as a satellite in a circular orbit (a) at the height of 2Re from the CoE. The red spot shows camera coverage for FoV =0.52-degree, Magenta for FoV=40 degree, and yellow for the FoV of 170 degree (b) from the height of $220R_E$ from the CoE. For which almost half of the hemisphere is covered by these three FoVs of the camera. Thus, even with a viewing angle equal to the visual angle of 0.5 degrees, the whole Earth becomes visible as a disc covering Sunlit and dark areas from the height of J-S points.

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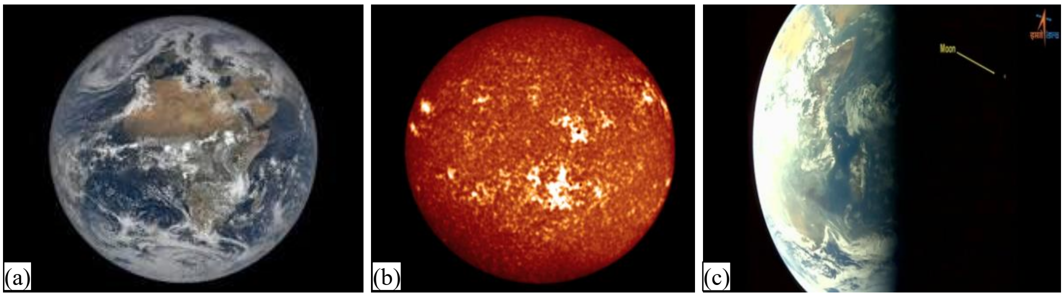

Figure 23. (a) Whole sphere of the Earth taken by EPIC camera of DSCOVR satellite (https://epic.gsfc.nasa.gov/); (b) whole disc of the sun taken by SUIT camera of ISRO's Aditya-L1 satellite (https://www.isro.gov.in/Aditya_L1_SUIT.html); (c) Image of Earth and the Moon taken together by ISRO's Aditya-L1.

CONCLUSIONS AND FUTURE CHALLENGES

In this paper, a detailed study on the description of space journey by two vulture brothers, as depicted in Maharshi *Balmiki's Ramayana*, was presented with the aim of estimating the height they attained in space during their space travel. To the best of our knowledge, the description presented in that epic is one of the most ancient descriptions of observation of the Earth from the gradually increasing heights in space [40, 36], which accounts for the unique contribution of India in the area of space exploration since antiquity. Here, in this study, the height of observation of the Earth from a location in space from where the Sun and the Earth are perceived as of the same size and shape, even though the Sun is many times bigger than the Earth, was estimated using the textual descriptions given in the *Ramayana*. The term used in the textual description can be interpreted as referring to equality in shape and size, and on that ground, Maharshi Valmiki can be considered one of the earliest astronomers who spoke about the round shape of the Earth. However, the world generally recognizes Pythagoras and later Aristotle as the ancient mathematicians who stated that the Earth is round. However, Maharshi Valmiki did not write directly about the roundness of the Earth, but such an interpretation can be taken. The estimated heights of such locations in space are of the order of 10^6 *km,* ranging from 210 R_E *km* to 220 R_E *km*. However, whether J-S brothers reached to which of such a J-S point cannot be ascertained here. It is stated in the epic Ramayana [8] that they took off their journey from the peak of *Kailash Mountain* in the direction of the Sun, which may be helpful in doing research in the area of trajectory planning and satellite launching. The estimated height is a very large height at which a vulture cannot survive without advanced life support. It is unbelievable , unacceptable and seems indigestible. But the calculations using ECI coordinates and the science of size perception based on visual angles also give an estimate of the height of a similar order for J-S brothers. Such estimated locations in space have been named here as J-S points. In the calculations of heights of J-S points, the known science of size and distance perception, as happens in humans was used; however, it may be different in the avian family, which is still unexplored [37]. Thus, if some different mathematical models of size and distance perception in birds are coined in the future, the estimated height of J-S points may change accordingly, but the height estimated geometrically will remain the same. The estimated height of J-S brothers is too large to believe and accept, undoubtedly on many grounds. The source texts neither contain any description of their height of flight in space in numerical figure nor any scientific analytics for the same. The eagles typically fly at heights of 4,500 to 6,000 meters (around 15,000 to 20,000 feet) for hunting or migration, but they can also reach higher altitudes. However, sustained flight at 10 km (which is the typical range for commercial airliners) is extremely rare and close to the physiological limits for most of the birds due to low oxygen levels and hostile temperatures profiles. In one of the modern studies, the highest-flying bird confirmed is the Rüppell's vulture, which has been recorded flying at the height of 11.3 km (37,000 feet) [38]. The estimated altitude attained by J-S brothers is very large and located somewhere in deep space near the Hill sphere. The radius of the Hill sphere for the Earth is about 1500000 km, which is about 1% of the distance between the Sun and the Earth, and thus J-S points represent locations near the outer extreme of the Earth's Hill sphere. Such locations are very near the Lagrangian point L_1 where the gravitational forces or effects of the Earth and the Sun cancel each other. Currently, many satellites are observing the Sun, such as DSCOVR (Deep Space Climate Observatory) satellite, ISRO'S

Aditya-L1, orbiting there to observe the Sun continuously. The orbits at such levels are very unstable, and the gravitational pull of the Sun starts to show its existence. From the J-S points, the Earth and the Moon separation will be seized, and their photograph can be taken on the same canvas in one FoV as has been released by the ISRO in 2023, taken by the camera of the Aditya-L1 satellite. The DSCOVR can also take a photograph of the whole Earth in one frame, and such photographs have also been released. Those released pictures, as shown in Figure 23, the Earth looks like a blue marble and the Moon as a greyish nearby dot, and the whole rotation of the Moon around the Earth can be seen in the same FoV. As stated earlier, *Sage Valmiki*, the composer of the epic *Ramayana*, had a great sense of astronomy and had stated that the J-S brothers reached near *Suryamandal*, which represents the territory of the Sun, like the Hill sphere of the planet. Thus, such an idea and the use of terms like *Suryamandal* by our ancient scholars indicate their higher level of knowledge and understanding about the deep space. Although at such heights, survival of J-S brothers without suitable life support is impossible because the edge of space is technically defined at 100 km, known as Karman Line, and the death zone starts much below the space edge line. Beyond the space edge is called outer space, and the atmospheric layers end at the outer layer of exosphere at about 10,000 km with rare traces of life-giving gas oxygen. The estimated distances of J-S points are much greater. It is nearly three times the distance of the Moon from the Earth's surface. At such heights, there is no air pressure, no oxygen, and no magnetic shield to protect from cosmic radiation and the solar wind of charged particles. Under such conditions, all the highly fatal processes such as hypoxia, ebullism, radiation poisoning, lethal exposure to solar wind, etc., will take lives in no time. Thus, it is very important and interesting to investigate how the J-S brothers could survive in the journey and for some time at the estimated height from where they got drop after facing fatal burn and seizure of brain power and other body functions. Only then, their space journey up to the estimated height can be justified. However, the descriptions of the flight of J-S brothers, as given in the epic *Ramayana*, are very valuable, and perhaps it is one of the oldest records of space mining. Thus the space odyssey of J-S Bro also represents India's presence in space at a very handsome height since antiquity. In fact, the same truth, which has been presented about the size of the Earth and the Sun by *Maharshi Valmiki* in the epic, has also been captured today by the EPIC (Earth Polychromatic Imaging Camera) camera of satellite DSCOVR and the SUIT (Solar Ultraviolet Imaging Telescope) camera of ISRO'S Aditya-L1 satellite, as shown in Figure 23. Both satellites are orbiting around the L_1 point and have access to the Sun for 24×7 hours. This is breathtaking and stunning height, and to the best of our knowledge, nobody except J-S Bro. has observed so far such things in black space wherein the Earth and the Sun look like a disc of the same size.

Thus, the descriptions of the great astronomer and sage *Maharshi Valmiki* about deep space and the presentation of related observations of the Earth and the Sun by the J-S brothers are perhaps highly valuable and are also the most ancient records of space travel. However, research and innovations are further required in many directions, such as estimation of the shape of the *Valmiki sphere*, travel management of J-S brothers and their science of survival in highly lethal conditions at such a stunning height, estimation of the shape and size of eye sockets of J-S brothers, etc., which will reveal other truths of the Indian legacy [12, 41, 42] in space science. Many questions and doubts, such as how the J–S brothers survived at such a great height, whether oxygen was available up to that height at that time, and if so, whether the atmospheric profile has been shrinking toward the Earth, remain unanswered. Questions such as how the J–S brothers planned their launch trajectory from the Earth to deep space, and many others, also remain unresolved. At this concluding point of the paper, answers to these research questions and all the descriptions made in the Ramayana require a high level of interdisciplinary knowledge to develop scientifically verifiable and valid arguments. The sky is open for researchers to explore, and many more interesting aspects can be examined and gleaned to demonstrate and establish the ancient Indian tradition of specialized knowledge before the world.

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REFERENCES

1. United Nations Conference on Trade and Development. Exploring Space Technologies for Sustainable Development. Geneva: United Nations; 2021. Available from: https://unctad.org/system/files/official-document/dtlstict2021d1_en.pdf
2. Darrin A, O'Leary BL. History of the space age. In: Darrin A, O'Leary BL, editors. Handbook of Space Engineering, Archaeology, and Heritage. Boca Raton (FL): CRC Press; 2009. Chapter 1. doi:10.1201/9781420084320.
3. Powell J. (2023). Ancient astronauts and the very, very early Space Race. [online] BBC Sky at Night Magazine. Available from: https://www.skyatnightmagazine.com/space-missions/ancient-astronauts-rockets
4. Tsiolkovsky KE. Exploration of the universe with reaction machines. Sci Rev. 1903;5. [Russian].
5. Anyam Veera VNP, Mishra AK. Ancient world of aerospace. REST J Adv Mech Eng. 2023;2(1):1–3.
6. Somnath S. Innovation in space technology. Yojana. 2023 May.
7. Mani S, Dadhwal VK, Shaijumon CS. Space economy of India, its impact on the rest of the economy. Space Policy. 2025;73:101692. doi:10.1016/j.spacepol.2025.101692.
8. Maharshi Balmiki. (2026). Valmiki Ramayana: Kishkindha Kanda—Sarga 61 [online]. Desiraju Hanumanta Rao. Available from: https://www.valmikiramayan.net/utf8/kish/sarga61/kishkindha_61_frame.htm
9. Venkatraman R. (2024). Sampāti and Jaṭāyu – many layers of a “side-story”. [online] Pragyata. Available at: https://pragyata.com/sampati-and-ja%E1%B9%ADayu-many-layers-of-a-side-story/
10. Bala S. (2026). Scientific Dating of Ancient Events from 7000 BC to 2000 BC. [online] Vivekananda International Foundation. Available from: https://www.vifindia.org/transcriptions-paper/2012/07/03/scientific-dating-of-ancient-events-from-7000-bc-to-2000-bc.
11. Rao N. Date of Shri Rama. Chennai: International Society for the Investigation of Ancient Civilizations; 1990.
12. Peters NM, Beale CM, Bracebridge C, Mgumba MP, Kendall CJ. Combining models for animal tracking: defining behavioural states to understand space use for conservation. J Biogeogr. 2022;49(11):2016–2027. doi:10.1111/jbi.14483.
13. Bala S. Historicity of Ramayan era: scientific evidences from the depths of oceans to the heights of skies. In: Bala S, Mishra K, editors. Historicity of Vedic and Ramayan Eras: Scientific Evidences from the Depths of Oceans to the Heights of Skies; proceedings of seminar held in New Delhi, India, Jul 30–31, 2011. Hyderabad: Institute of Scientific Research on Vedas (I-SERVE); 2012. p. 223–254. Available from: https://www.sarojbala.com/wp-content/uploads/2023/10/saroj-bala.pdf
14. Tatem AJ, Goetz SJ, Hay SI. Fifty years of Earth observation satellites: views from above have led to countless advances on the ground in both scientific knowledge and daily life. Am Sci. 2008;96(5):390–398. doi:10.1511/2008.74.390. PMID: 19498953.
15. Lamboglia E, Cambone G, Del Frate F, Mogha VP. The evolution of Earth observation: exploring space sustainability through European case studies. Int J Sustain Eng. 2024;17(1):632–641. doi:10.1080/19397038.2024.2387427.
16. Bohren CF, Fraser AB. At what altitude does the horizon cease to be visible? Am J Phys. 1986;54(3):222–227. doi:10.1119/1.14659.
17. French AP. How far away is the horizon? Am J Phys. 1982;50:795–799. doi:10.1119/1.13099.
18. Gorkavyi N, Krotkov N, Marshak A. Earth observations from the Moon’s surface: dependence on lunar libration. Atmos Meas Tech. 2023;16:1527–1537. doi:10.5194/amt-16-1527-2023.
19. Yao X, Toslak D, Son T, Ma J. Understanding the relationship between visual-angle and eye-angle for reliable determination of the field-of-view in ultra-wide field fundus photography. Biomed Opt Express. 2021;12:6651–6659. doi:10.1364/BOE.433775. PMID: 34745762.
20. Sousa R, Smeets JBJ, Brenner E. The influence of previously seen objects’ sizes in distance judgments. J Vis. 2013;13(2):2. doi:10.1167/13.2.2. PMID: 23378131.
21. Tanaka S, Fujita I. Computation of object size in visual cortical area V4 as a neural basis for size constancy. J Neurosci. 2015;35(34):12033–12046. doi:10.1523/JNEUROSCI.2665-14.2015. PMID: 26311782.

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22. Nguyen AP, Spetch ML, Crowder NA, Winship IR, Hurd PL, Wylie DRW. A dissociation of motion and spatial-pattern vision in the avian telencephalon: implications for the evolution of visual streams. J Neurosci. 2004;24(21):4962–4970. doi:10.1523/JNEUROSCI.0146-04.2004. PMID: 15163688.
23. Murray SO, Boyaci H, Kersten D. The representation of perceived angular size in human primary visual cortex. Nat Neurosci. 2006;9(3):429–434. doi:10.1038/nn1641. PMID: 16462737.
24. Gilinsky AS. Perceived size and distance in visual space. Psychol Rev. 1951;58(6):460–482. doi:10.1037/h0061505. PMID: 14900306.
25. Kim NG. A binocular information source for size perception. Front Psychol. 2017;8:2078. doi:10.3389/fpsyg.2017.02078. PubMed PMID: 29255437.
26. Shlaer R. An eagle's eye: quality of the retinal image. Science. 1972;176:920–922. doi:10.1126/science.176.4037.920. PMID: 5033635.
27. Olsson P. Colour vision in birds: comparing behavioural thresholds and model predictions [dissertation]. Lund (Sweden): Lund University, Faculty of Science, Department of Biology; 2016.
28. Walls GL. The vertebrate eye and its adaptive radiation. New York (NY): Hafner Publishing Co.; 1942.
29. Pusch R, Clark W, Rose J, Güntürkün O. Visual categories and concepts in the avian brain. Anim Cogn. 2023;26(1):153–173. doi:10.1007/s10071-022-01711-8. PMID: 36352174.
30. Bawa SR, YashRoy RC. Vulture retina enzyme distribution and function. Neurobiology. 1972;2(4):162–168. PMID: 4218304.
31. Nityananda V, Bissinna G, Tarawneh G, Read J. Small or far away? Size and distance perception in the praying mantis. Philos Trans R Soc Lond B Biol Sci. 2016;371:20150262. doi:10.1098/rstb.2015.0262. PMID: 27269605.
32. Tyrrell LP, Fernández-Juricic E. Avian binocular vision: it's not just about what birds can see, it's also about what they can't. PLoS One. 2017;12:e0173235. doi:10.1371/journal.pone.0173235. PMID: 28355250.
33. Luneburg RK. Mathematical analysis of binocular vision. Princeton (NJ): Princeton University Press; 1947.
34. Todd JT, Thaler L, Dijkstra TMH, Koenderink JJ, Kappers AML. The effects of viewing angle, camera angle, and sign of surface curvature on the perception of three-dimensional shape from texture. J Vis. 2007;7(12):9. doi:10.1167/7.12.9. PMID: 17997651.
35. Ionascu EJ, Circle A. Spherical geometry. Int J Geom. 2020;9(1):75–84.
36. Wolbarsht ML, Lockhead GR. Moon illusion: a new perspective. Appl Opt. 1985;24(12):1844. doi:10.1364/AO.24.001844. PubMed PMID: 18223803.
37. Martin GR. Avian vision. Curr Biol. 2022;32(19):R1079–R1085. doi:10.1016/j.cub.2022.06.065. PubMed PMID: 36283369.
38. Carwardine M. Highest flying birds. In: Birds. Natural History Museum animal records. New York (NY): Sterling Publishing; 2008. p. 124. ISBN: 9781402756238.
39. Rainey RCT. Long-term changes in the Earth's climate: Milankovitch cycles as an exercise in classical mechanics. Am J Phys. 2022;90(11):848–856. doi:10.1119/10.0013563.
40. Uri J. (2020). 90 Years of Our Changing Views of Earth. [online] NASA. Available from: https://www.nasa.gov/history/90-years-of-our-changing-views-of-earth/
41. Palotas TL, translator. (2026). Yoga Vasishta - The Means of Liberation. Book III-A On Creation (Utpatti Khanda) (Utpatti Khanda), chapters 1–60. [Online]. Yoga Vasishta. Available from: https://yogavasishta.org/book3a-ch1-60.html
42. Kochhar R. Scriptures, science and mythology: astronomy in Indian cultures. Proc Int Astron Union. 2009;5(S260):54–61. doi:10.1017/S1743921311002146.

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