

The overall structure of the small world of Sutras

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Abstract

This paper tries to put aside all the religious clothing and various folk myths and legends¹, only from the angle of modern science to interpret the cosmology expounded by the Sutras² more than 2500 years ago. First, we assume that the Buddha of more than 2,500 years³ ago had only the astronomical and geographic knowledge of ordinary people of his time and place, such as the flat-earth theory that we live on a huge flat surface. Secondly, we make a strict logical deduction according to this hypothesis and the description of Buddhist sutras, in order to test whether the description of Buddhist sutras meets this hypothesis. However, in the rigorous reasoning described by the Buddhist scriptures, we gradually overturn this assumption. Finally, **thanks to modern science**, we are surprised to find that the Buddha's knowledge of the structure of the earth is beyond our imagination, and there is an **incredible era transcendence**.

Key words: Era transcendence

1 Introduction

According to ancient texts such as the «Aggañña Sutta»⁴ and «Buddha Spoke of Dirghagama Sutra»⁵, one day, the Buddha (c. 6th to 5th century BCE) or (c. 5th to 4th century BCE) [5, 22] and his disciples gathered at the Kalilo Grotto in the city of Serapha Sidi⁶ in ancient India more than 2,500 years ago. After the meal, the bhikkhus (disciples) gathered in the Kalilo Hall⁷ and

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¹Readers are also invited to abandon the religious mythological images elaborated in all literature, art, film and television works including «Journey to the West» [7].

²It mainly focuses on the «Aggañña Sutta» [3, 24], and also gives consideration to other related Sutras, such as the «Buddha Spoke of Dirghagama Sutra» and the «Shurangama Sutra» [14].

³The date is disputed, with some saying it was more than 3,000 years ago.

⁴There are two different Chinese translations. One is by Dharmagupta [2, 25]. And we use the version by Jñānagupta [8].

⁵Also named «Dīrgha Āgama» or «Dirgha Agama». **The basic classics of primitive Buddhism.** [4, 23] One of the four ahm divisions of Northern Buddhism. Named because of the length of the collection.

⁶Another transliteration, Shibharti City. And «Buddha Spoke of Dirghagama Sutra» records for the kingdom of Sherwei.

⁷Another transliteration, The Carillo Stone Chamber.

discussed with each other an idea proposed by the Buddha, which even the knowledgeable elders of the time said was unheard of, and which seemed to all present to be indescribable. This is a question about the land (world) of sentient beings, namely:

In the present, the world, the homeland for all living beings, how rotates to merge, how rotates to separate, how rotates separated but merges again later, how settles after the rotated merging.

(Related Chinese: 今此世间。天地众生。所居国土。云何转合。云何转散。云何转散已而复还合。云何转合已而安住也。 [26])

In modern terms, this is how the earth (the world) in which living beings live in merges in rotation, spreads out in rotation, spreads out in rotation, merges again in rotation, and finally settles. The Buddha first introduced the concept of “**three thousand large thousand worlds**” (or “**one billion worlds**”) in order to explain this idea, which many elders find strange, and began a complete introduction to the Buddhist view of the universe.

2 The earth’s surface shape

In order to better answer the previous question about “the land of living beings”, and to better describe the changing process of the universe and other related things, the Buddha first introduced a concept that can be easily understood by the public, as “the move range of the sun and the moon” for the first unit of spatial scope. Please take a look at the following excerpt from Jambudvīpa Chapter 1 of Volume 1 of «Aggañña Sutta» :

For all the Buddhists, the land is four hundred eighty thousand yojana thick while broad boundless. For all the Buddhists, this land is on top of the water and the water is on top of the wind while the wind is in vacancy. For all the Buddhists, the water aggregates is six hundred thousand yojana thick and broad boundless. Under the water aggregates, there is wind aggregates which is three hundred and sixty thousand yojana thick and broad boundless. For all the Buddhists, the depth of the deepest ocean is eighty four thousand yojana and the ocean is broad boundless. For all the Buddhists, the Sumeru Mountain has its height of eighty four thousand yojana below ocean surface and also has the height of eighty four thousand yojana above the ocean surface. For all the Buddhists, the Sumeru Mountain has a flat bottom and its root connects to a big golden wheel.

(Related Chinese: 诸比丘。此大地厚四十八万由旬。边广无量。诸比丘。此之大地住于水上。水住风上。风依虚空。诸比丘。此大地下所有水聚。彼水聚厚六十万由旬。边广无量。彼水聚下所有风聚。彼风聚厚三十六万由旬。边广无量。诸比丘。其大海水最甚深处。深八万四千由旬。边广无量。诸比丘。其须弥山王。入海水中八万四千由旬。出海水亦八万四千由旬。诸比丘。须弥山王。其底平正。下根连住大金轮上。 [26])

In this paragraph, the Buddha begins by introducing the world associated with the earth at his feet. In the sentence “the land is four hundred eighty thousand yojana thick”, “the land” refers

to the earth under the feet of the masses. Because the entire «Aggañña Sutta» is the Buddha's answer to his followers' question in the Kalilo grotto in the sidi city of Serapha, and the question is about "the world, the homeland for all living beings" which has mention previously. **If this land is the earth of some other world (if there is one) unrelated to the asker, it is obviously not the answer to the question and does not make sense as an answer from a man who has the highest wisdom title. And the masses were in the City of Seraphasidi, in the Kalilo caves, somewhere in ancient India. Furthermore, ancient India was on earth, so "this land" must relate to earth as we know it.**

From now on, we refer to the areas of the sun and moon as "world" (similar to the solar system), and the areas associated with the earth as "small world" (similar to the Earth). Obviously, the earth (land) is a center of gravity described by buddhist scriptures.

If we look carefully at the concepts presented in the above paragraph, we will find the following 9 objects: 1. The land. 2. Water. 3. Wind. 4. Vanity. 5. Water aggregates. 6. Wind aggregates. 7. Ocean. 8. Sumeru Mountain. 9. Big golden wheel.

So, this paragraph describes a series of unknown objects and their spatial relationship, which we won't read too much into here since we need more information. In buddhist sutras, "Sumeru Mountain" is the starting point for the Buddha to introduce various regions in his small world, just as people need to start with a famous landmark to introduce a city, for example, we can start with the Forbidden City in Beijing to introduce the landscape of Beijing. The "Sumeru Mountain" serves as this calibration, and the Buddha also used this logic of introduction, which is equivalent to the origin of the coordinates of the introduction. Here we do not over-interpret whether "Sumeru Mountain" is a mountain, if it is a mountain, which mountain it refers to, and if not, what it refers to. We need context and more to understand it. Now let's take a look at the following excerpt from Jambudvīpa chapter 1 of Volume 1 of «Aggañña Sutta» :

For all the Buddhists, there a continent to the north of Sumeru Mountain, named Uttarakuru.

(Related Chinese: 诸比丘。须弥山王北面有洲。名郁多罗究留。 [26])

For all the Buddhists, there a continent to the east of Sumeru Mountain, named Purvavideha.

(Related Chinese: 诸比丘。须弥山王东面有洲。名弗婆毗提诃。 [26])

For all the Buddhists, there a continent to the west of Sumeru Mountain, named Godānīya.

(Related Chinese: 诸比丘。须弥山王西面有洲。名瞿陀尼。 [26])

For all the Buddhists, there a continent to the south of Sumeru Mountain, named Jambudvīpa.

(Related Chinese: 诸比丘。须弥山王南面有洲。名阎浮提。 [26])

In this section, Buddha takes "Sumeru Mountain" as the landmark and introduces four regions named "continents" one by one, which are distributed in order to the north, east, west and south of the "Sumeru Mountain".

the east direction of Jambudvīpa” obviously causes a **direction loop**. And we can show that on a 2-dimensional plane, no matter how you arrange the positions of these four regions, you can’t generate a circular relationship in orientation.

The proof is very simple, and we can consider the simple case, that is, if there are only two regions, whether a circular distribution in orientation can be produced on a 2-dimensional horizontal plane. On a horizontal plane, when considering only east-west directions, you can start by placing region A anywhere, and then place region B either to the left of A (to the west of A) or to the right (to the east of A), but neither side will produce a circular east-west relationship. So is true for the four regions. Therefore, we can be sure that the four regions are not on the same plane and the **“Small world nestle map” (Fig. 1) putting them on the same plane is a big mistake.**

Then the Buddha said, “And so are the direction relations between south and north.” Think about it, what kind of spatial structure can lead to both circular east-west connectivity and circular north-south connectivity? We do not assume the Buddha’s space-time structure here and if we only consider the spatial structure of less than or equal to 3 dimensions⁸, since the possibility of two dimensions was ruled out, the four regions could only be distributed on the surface of some huge three dimensional object, because only then could azimuth cycle be allowed.

So, is this giant three-dimensional object a cube? Or a sphere? Or any other shape? The Buddha did not say so explicitly. In order to match the ancients’ view of “the sky is round and the earth is flat”, we assume a square cube here. Based on the constraints of the circular relationship analyzed above, without loss of generality, the four regions are distributed on the front, back, left and right sides respectively. We also temporarily ignore the north-south circular relationship. At the same time, according to the observation experience of the sun rotating around the earth in the sky and in accordance with the ancients’ belief that the sky is round and the earth is flat, we assume that the sun revolves around the cube above. We put all above into Fig. 2. Now, let’s take a look at the next excerpt from Chapter 12 of Volume 10 of «Aggañña Sutta»:

Again, for all the Buddhists, when it is midday in Jambudvīpa, it is sunset in Purvavideha, sunrise in Godānīya and midnight in Uttarakuru. When it is midday in Godānīya, it is sunset in Jambudvīpa, sunrise in Uttarakuru and midnight in Purvavideha. When it is midday in Uttarakuru, it is sunset in Godānīya, sunrise in Purvavideha and midnight in Jambudvīpa. When it is midday in Purvavideha, it is sunset in Uttarakuru, sunrise in Jambudvīpa and midnight in Godānīya.

(Related Chinese: 复次诸比丘。若阎浮提洲日中。于弗婆提洲则日没。其瞿陀尼洲日出。郁多罗究留洲正夜半。若瞿陀尼洲日中。其阎浮提洲日没郁多罗究留洲日出。弗婆提洲夜半。若郁多罗究留洲日中。其瞿陀尼洲日没。弗婆提洲日出。阎浮提洲夜半。若弗婆提洲日中则郁多罗究留洲日没。阎浮提洲日出。瞿陀尼洲夜半。[27])

This section describes the cyclic relationship of the four regions in time with sunrise and sunset. Here we emphasize an everyday observation experience familiar to all ages: each day, the

⁸In fact, in the absence of other evidence, we should try to follow the perception of three-dimensional spatial structure formed in daily life and production from ancient times to today.

sun rises from the eastern horizon (sunrise), moves into the middle of the sky (overhead, but not necessarily vertically) at noon, and sets in the evening from the western horizon (sunset). Based on this common sense, the model assumptions that we've made and the description of this paragraph, let's see what we can get from Fig. 2.

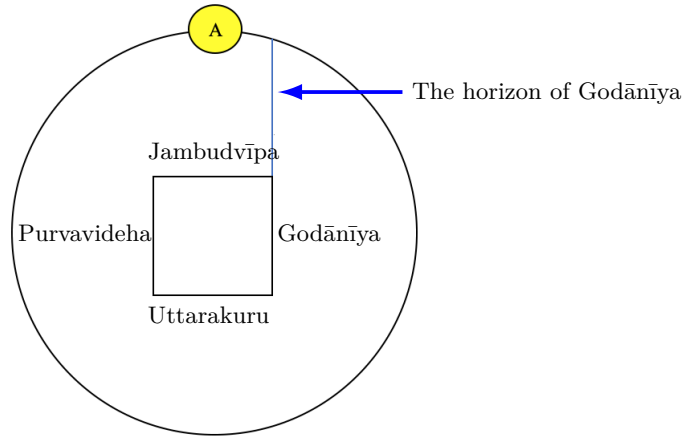


Fig. 2: A diagram of the imaginary orbit of the sun

Fig 2 is a bird's eye view, that is, from above the North Pole of the cube earth (assumed to be a cube above) to the South Pole. The middle square represents the Earth, and the outer great circle represents the orbit of the sun, that is, rotating around the equator with four regions distributed on four planes around the equator.

Apparently, when it is midday in Jambudvīpa, that is, when the sun moves to point A, it is indeed midnight in Uttarakuru. But the Godānīya is not at sunrise as the scriptures say, only when the sun is at the intersection of its orbit (the great Circle) and the horizon of the Godānīya. The Purvavideha had already set the sun for more than 6 hours, which contradicted the description of the scripture.

If we also assume that the orbit of the sun (the large circle in Fig 2) is exactly tangent to the square, that is, the four corners of the earth that the sun hits during its orbit, then a person in the middle of the Purvavideha will find that the sun is significantly larger at noon than at sunrise and sunset. In fact, there are no such stable observations in ancient or modern times. Taking these two points together, we can conclude that even if the sun goes around the earth, the earth cannot be a cube. **A three-dimensional object that fits the description of scripture must be a sphere or nearly a sphere.**

3 The hierarchy of underground

With above conclusion in mind, we return to the unexplained scripture at the beginning of the previous section:

For all the Buddhists, the land is four hundred eighty thousand yojana thick while broad boundless. For all the Buddhists, this land is on top of the water and the water is on top of the wind while the wind is in vacancy. For all

the Buddhists, the water aggregates is six hundred thousand yojana thick and broad boundless. Under the water aggregates, there is wind aggregates which is three hundred and sixty thousand yojana thick and broad boundless.

(Related Chinese: 诸比丘。此大地厚四十八万由旬。边广无量。诸比丘。此之大地住于水上。水住风上。风依虚空。诸比丘。此大地下所有水聚。彼水聚厚六十万由旬。边广无量。彼水聚下所有风聚。彼风聚厚三十六万由旬。边广无量。 [26])

After reading this passage, we now know that what is called the relationship between “on top of” and “under” is actually the relationship between the upper and the lower within the earth. And this description of the interior of the earth means “Underneath the solid aggregates (earth) is the liquid polymer (water aggregates), and below the liquid polymer is the gaseous polymer (wind aggregates).” The words “wood, water, fire and earth” in ancient Chinese are not directly equivalent to metals, wood, liquid water, fire and earth in daily life, and need to be inferred from the context.

This passage refers to “the wind is in vacancy”. where we need to comprehensively analyze the meaning of it here. First of all, there is no “wind is on top of the vacancy” like the previous “this land is on top of the water” and “the water is on top of the wind”, which is logically inconsistent with the previous. Therefore, we believe that there is no up and down relationship between “wind” (i.e., wind aggregates) and “vacancy”.

Secondly, the “land”, “water aggregates” and “wind aggregates” are all described with “boundless”⁹ but there is no such expression for “vacancy”. At the same time, there is no concept of “vacancy aggregates”, so we think “vacancy” is not the same as “land”, “water aggregates” and “wind aggregates”.

Finally, the pressure inside the Earth is so great that it is impossible to create a pressure-free vacuum (void). It must be filled.

To sum up, we believe that “the wind is in vacancy” means “wind (aggregates) is suspended in the space”. And according to “this land is on top of the water and the water is on top of the wind while the wind is in vacancy.”, the scripture indirectly indicates that the earth is suspended directly in the (outer) space.

At this point, we have reason to believe that the Sutras describe the earth’s interior, which is composed from top to bottom of three layers of state of matter: solid earth, liquid polymer and gaseous polymer.

At the same time, according to “the land is four hundred eighty thousand (480,000) yojana thick”, “the water aggregates is six hundred thousand (600,000) yojana thick” and “there is wind aggregates which is three hundred and sixty thousand (360,000) yojana thick”, we can know the sum of the thickness of the three layers is 1.44 million yojana, and the ratio is 4:5:3.

According to modern geography, the depth of the earth is 6,371 kilometers [18], we can convert 1 yojana to $6,371,000 \div 1,440,000 \approx 4.42$ meters. Therefore, according to the above ratio, the boundary between solid and liquid layers in the underground described by Buddhist sutras is proportionally located at 2,124 kilometers, and the boundary between liquid and gas layers is proportionally located at 4,778 kilometers underground.

⁹We won’t discuss here why is “boundless”, rather than a specific number.

Name of the earth sphere			Depth (km)	Density (g/cm^3)	State of matter	
1 th order stratification	2 nd order stratification	Traditional stratification				
Outer Sphere	Crust		Crust	0 - 33	2.6 - 2.9	Solid matter
	Outer transition zone	Outer transition zone (Upper)	Upper mantle	33 - 980	3.2 - 3.6	Part of the molten matter
		Outer transition zone (Lower)	Lower mantle	980 - 2900	5.1 - 5.6	Liquid-solid Matter
Liquid sphere	Liquid zone		Outer core	2900 - 4700	10.0 - 11.4	Liquid matter
Inner Sphere	Inner transition zone		Transition zone	4700 - 5100	12.3	Liquid-solid matter
	Core		Inner core	5100 - 6371	12.5	Solid matter

Tab. 1: Table of solid earth structure [18]

From modern geography [18] (as shown in Tab. 1) we know that the lower mantle, which is a transitional layer from solid to liquid, lies between 980 kilometers and 2,900 kilometers deep underground. According to buddhist scriptures, the first boundary of the state of matter, that 2,124 kilometers, **is located in the middle of this range**. Secondly, from modern geography [18] (as shown in Tab. 1), the underground depth of 4,700 kilometers to 5,100 kilometers is the transition layer from liquid to solid, and also the transition layer between the outer core and the inner core of the earth. According to buddhist scriptures, the second boundary of the state of matter, which is 4,778 kilometers, **is also within this range**.

Here, the Buddha's division of the structure of the earth's interior basically conforms to the first-order stratification of modern geography, namely "outer sphere-liquid sphere-inner sphere". At the same time, we know that in the description of this passage, the Buddha did not divide the layers according to the transverse and longitudinal velocity of seismic waves [18], but according to the state of matter. This leads to a slight difference in the specific boundaries, but also in the transition layers recognized by modern science.

One of the things you'll notice here is that the Buddha thought the inner sphere (core) of the earth was a gas (gaseous polymer), whereas modern science generally thinks it's a solid, which seems a different view. However a gaseous polymer can also be a plasma [11] which consists of a gas of ions -atoms or molecules which have one or more orbital electrons stripped (or, rarely, an extra electron attached), and free electrons. Hence, if the inner core is a plasma with the density of a solid [1, 12], there is no conflict with modern science view that Earth's inner core is a solid ball.

4 Conclusions

Conclusion 4.1 *There is a contradiction between the ancients' hypothesis that "the earth is flat" and the description of Buddhist scriptures. The Buddha was fully aware that the land we live on is distributed over a three-dimensional spherical object, that is, the earth is a sphere not flat!*

Conclusion 4.2 *Buddha had an accurate understanding of the earth's internal structure,*

material form, etc., and an accurate numerical scale description of the layered structure of the earth.

Conclusion 4.3 *Buddha's division of the structure of the earth basically conforms to the first-order stratification of modern geography, namely "outer sphere-liquid sphere-inner sphere", as shown in Fig 3. At the same time, we know that the Buddha did not divide the layers according to the transverse and longitudinal velocity of seismic waves [18], but according to the state of matter with "some unknown intuitive perception".*

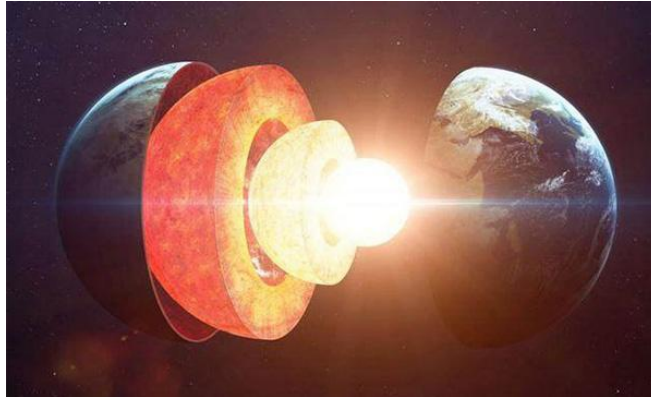


Fig. 3: Internal structure of the Earth, Credit: Internet

Conclusion 4.4 *The measurement unit "yojana" we converted is approximately 4.42 meters instead of around 14.6 kilometers [13] (or 11.2 kilometers [21]) as is commonly believed.*

5 Discussions

Ask: If the Buddha knew that the earth was a sphere, why didn't he just say so?

Answer: We think the reasons are as follows:

- (1) More than 2,500 years ago, when almost everyone believed in the flat-earth theory, stating that the earth lay on the surface of a sphere was bound to cause great controversy and intense skepticism. This, in turn, is bound to seriously affect the Buddha's main work of civilizing sentient beings, and even lead to unpredictable and sinister consequences. For example: Giordano Bruno (1548-1600) [6, 16], an Italian thinker, naturalist, philosopher and litterateur of the Renaissance, bravely defended and developed Copernicus' theory of the center of the Sun and spread it throughout Europe. This doctrine made him a prominent figure in his own time, and he was imprisoned in 1592, eventually condemned by the Inquisition as "heretical". He was burned to death in the Piazza de 'Fiori in Rome on February 17, 1600.
- (2) The theory of the spherical earth [17] was not put forward during the Renaissance. In fact, the ancient Greek mathematician Pythagoras proposed the concept as early as the 6th century BC. The concept of the earth was established by Eratosthenes, a scientist living in Alexandria, around the third century BC, using geometric methods. So knowing that the earth was round more than 2,500 years ago was not unusual, but it was certainly prophetic.

(3) In «Shurangama Sutra»¹⁰, the sutras **highly suspect** that the world we live in is a sphere:

And Aniruddha perceives Jambudvīpa, just like watching āmalaka on palm; (Related Chinese: 而阿那律见阎浮提, 如观掌中庵摩罗果; [14,15])



Fig. 4: Left subgraph is “And Aniruddha perceives Jambudvīpa, just like watching āmalaka on palm”[14,15]; Right subgraph is āmalaka (*Phyllanthus emblica* Linn [10], an indian gooseberry)

As shown in the left subgraph in Fig. 4. Here, according to our previous analysis, Jambudvīpa refers indirectly to the land (earth) where we humans live. And āmalaka [19] is the name of an Indian gooseberry, known in China as Yuganzi (*Phyllanthus emblica* Linn [10]), as shown in the right subgraph in Fig.4.

Here the āmalaka fruit metaphor of the earth is very vivid and accurate. First of all, both are spheres. Secondly, the peel, pulp and core of āmalaka fruit correspond to the traditional layered crust, mantle and core of the earth’s internal structure respectively. Finally, āmalaka fruit (as shown in the right subgraph of Fig.4), the ratio of pulp thickness and core radius is similar to that of the earth’s mantle thickness and core radius. And this consist with the scripture analysis of the internal structure of the Earth in the previous ”The hierarchy of underground” section (section 3).

Secondly, according to the above analysis, there are still many unsolved problems. For example, according to the previous measurement unit “yojana”conversion, we can calculate the height of “Sumeru Mountain”, that 84,000 yojana is about $84000 \times 4.42 = 371.28$ kilometers. As we all know, the highest mountain on the earth is 8848.86 meters of Mount Qomolangma [20] (Mount Everest [9]), its height of about 8.85 kilometers, far less than the above sea part of “Sumeru Mountain”, which is 371.64 kilometers. This shows that “Sumeru Mountain”cannot be equated with any mountain on earth in our common sense. So, what is the “Sumeru Mountain”and where on earth is it?

Besides, are the four continents really on earth? If so, where are they and how to verify? Is our previous conversion for “yojana”reasonable¹¹?

¹⁰ «Śūraṅgama Sūtra» [14]

¹¹It is worth noting that if this conversion is reasonable (which can be tested step by step in a future article), it logically follows that the Buddha also knew the length of the radius of the Earth. But at present we do not take “Buddha knew the length of the radius of the Earth”as the conclusion of this article, because we are based on the known radius of the earth to convert the length of the unit of measurement “yojana”.

Finally, in future articles, we will provide verifiable and logically consistent (**can be verified with the content of this article**) answers to these questions and more, including the logical verification of the internal description of scripture and the verification of relevant scientific observations. Readers will witness more “epochal transcendence” in the description of buddhist cosmology, which can “**verify each other**” and form an “**interlocking evidence chain**” .

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佛经小世界的整体结构

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2021 年 10 月 27 日

摘要：本文力求抛开一切宗教的外衣及各种民间神话传说¹，仅从现代科学的角度去解读 2500 多年前佛经²所阐述的宇宙观。首先，我们假设 2500 多年³前的佛陀只具备当时当地普通人的天文地理认知，譬如，认为我们生活在一块巨大的平面上的地平说或地平论。其次，我们根据这个地平说假设结合佛经描述做严格的逻辑推导，以检验佛经的描述是否满足这个地平说假设。然而，在佛经描述的严谨推理中，我们逐步推翻了这个假设。最后，得益于现代科学的研究成果，我们惊讶的发现，佛陀对地球结构的认知水平超出我们的想象，存在不可思议的时代超越性，让人叹为观止。

关键词：时代超越性

1 介绍

根据佛教早期经文《起世经》、《起世因本经》及《佛说长阿含经》⁴等古代文献的相关记载，大约在 2500 多年前的某一天，佛陀（释迦牟尼 [10]，公元前 623 年~公元前 544 年⁵，以下简称佛陀）和弟子们在古印度舍罗婆悉帝城⁶的迦利罗窟⁷中聚会。众比丘（弟子们）在吃过饭后聚集在迦利罗堂（讲法堂）内，互相讨论一个由佛陀提出的，连当时见多识广的老长们都表示闻所未闻，在场者无一不觉得匪夷所思的观点。这是一个关于众生土地（世界）的问题，即：

今此世间。天地众生。所居国土。云何转合。云何转散。云何转散已而复还合。云何转合已而安住也。[12]

用现代的话来说就是，现今这个世间，众生所生活的大地（世界）是如何在旋转中合并、如何在旋转中散开、如何在旋转中散开结束后又重新（在旋转中）合并而最后安住。佛陀为了解释这个连众多长老辈都觉得甚奇希有的观点，首次提出了“三千大千世界”的概念，开启了佛经宇宙观的完整介绍。

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¹也请读者抛弃包括《西游记》[9]在内的一切文学、艺术、影视作品所阐述的宗教神话形象。

²以《起世经》和《起世因本经》为主，同时兼顾其它相关佛经，譬如《佛说长阿含经》和《首楞严经》等。

³该时间存在争议，另一说为距今 3000 多年。

⁴原始佛教基本经典 [11]。北传佛教四部阿含之一。因所集各经篇幅较长，故名。

⁵另据汉译《善见律毗婆沙》“出律记”，推断为公元前 565 年至公元前 485 年。

⁶另一音译，舍婆提城。而《佛说长阿含经》的记载为舍卫国。

⁷另一音译，迦利罗石室。而《佛说长阿含经》的记载为祇树给孤独园俱利窟。

2 地表外形

为了更好的回答前面关于“众生所居国土”的问题，同时也为了更好的描述宇宙及其相关事物的变化过程，佛陀首先从大众容易理解的天体概念“日月”作为起点以及作为首个空间范围单位进行介绍。而“日月所行之处”就是一日月所行的范围。请看下面节选自《起世经一卷第一·阎浮洲品第一》的经文：

诸比丘。此大地厚四十八万由旬。边广无量。诸比丘。此之大地住于水上。水住风上。风依虚空。诸比丘。此大地下所有水聚。彼水聚厚六十万由旬。边广无量。彼水聚下所有风聚。彼风聚厚三十六万由旬。边广无量。诸比丘。其大海水最甚深处。深八万四千由旬。边广无量。诸比丘。其须弥山王。入海水中八万四千由旬。出海水上亦八万四千由旬。诸比丘。须弥山王。其底平正。下根连住大金轮上。[12]

在这一段里，佛陀从脚下的这片大地开始介绍与土地相关的世界。而“此大地厚四十八万由旬”的这句经文中，“此大地”就是指大众脚下的大地，因为整部《起世经》是佛陀在舍楞婆悉帝城迦利啰窟里回答众追随者的“今此世间。天地众生。所居国土。”的问题，**如果这个大地是与提问者无关的其他世界的大地（假设有的话），则显然是答非所问，不符合情理。而当时大众都在舍楞婆悉帝城迦利啰窟，也就是古印度的某个地方。而古印度在地球上，所以这个大地和我们知道的地球有关。**在此，我们把太阳和月亮所能照耀到的范围称为“世界”（类似于太阳系），而与大地相关的范围称为“小世界”（类似于地球）。显然，地球（大地）为佛经描述的一个重心。

如果我们认真整理这一段所出现的概念，会发现如下 9 种对象：1. 大地。2. 水。3. 风。4. 虚空。5. 水聚。6. 风聚。7. 大海。8. 须弥山王。9. 大金轮。

那么，这段经文描绘了一系列未知对象及它们在地理空间上的上下关系，我们在此处暂且不做过多解读。在佛经里，“须弥山王”是佛陀介绍小世界里各类地区的起始标定物，就像人们介绍某个城市需要从某个著名的地标开始一样，譬如我们可以从北京的故宫开始介绍北京市的地貌。“须弥山王”就起这个标定的作用，而佛陀也沿用了这种介绍逻辑，相当于介绍的坐标原点。在这里我们也不过度解读“须弥山王”究竟是不是山，如果是山，又是指哪座山，如果不是，又是指什么。我们需要结合上下文和更多的内容来综合理解，我们且看下面节选自《起世经一卷第一·阎浮洲品第一》的经文。

诸比丘。须弥山王北面有洲。名郁多啰究留。[12]

诸比丘。须弥山王东面有洲。名弗婆毗提诃。[12]

诸比丘。须弥山王西面有洲。名瞿陀尼。[12]

诸比丘。须弥山王南面有洲。名阎浮提。[12]

在这一段里，佛陀以“须弥山王”作为地标，逐个介绍了 4 个名叫“洲”的地区，依次分布在“须弥山王”北、东、西、南 4 个方位上。我们在这里暂且将它们简化为“郁、弗、瞿、阎”。补充说明一下，在古代朴素宇宙观的假设前提下，当你用东西南北来描述一个世界的时候，只能和我们生活的土地有关，离开地球，在外太空，是没有所谓的东西南北方位的。在“小世界安立图”（图1）里，这四个地区分布在“须弥山王”的四个方位上，而且处在同一个水平面。现在问题来了，佛陀在介绍的时候，没有说它们处在同一个水平面，也没有说它们不在同一个水平面。那么，这些洲处在同一个水平面吗？我们且看下面一段关于这 4 个地区方位关系的经文（节选自《起世经卷第十·最胜品第十二之余》）：

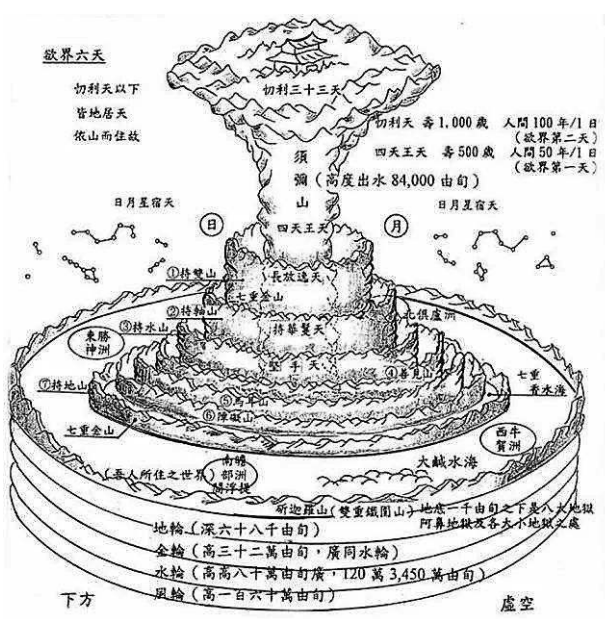


图 1: 错误诠释佛经的“小世界安立图”

诸比丘。其阎浮提洲人所有西方。瞿陀尼洲人以为东方。其瞿陀尼洲人所有西方。郁多罗究留洲人以为东方。其郁多罗究留洲人所有西方。弗婆提洲人以为东方。其弗婆提洲人所有西方。阎浮提洲人以为东方。南北二方。亦复如是。[13]

这一段以东西南北方位来描述这 4 个地区在方位上的循环交互关系。为什么这么说呢？在一个水平面上，如果我们按照左西右东的方式对 4 个地区进行排列，则从经文可以知道，其从左到右的顺序依次是“弗、郁、瞿、阎”，刚好对应了经文“诸比丘。其阎浮提洲人所有西方。瞿陀尼洲人以为东方。其瞿陀尼洲人所有西方。郁多罗究留洲人以为东方。其郁多罗究留洲人所有西方。弗婆提洲人以为东方。”这一部分。但是，经文接来说“其弗婆提洲人所有西方。阎浮提洲人以为东方。”，此时，**循环方位**关系产生了。而我们可以证明，在 2 维水平面上，无论你去排布这 4 个地区的位置，你也无法在方位上产生循环关系。这个证明非常简单，我们可以考虑简单的情况，即只有 2 个地区，在 2 维水平面上是否可以产生方位上的循环关系分布。在一个水平面上，在只考虑东西方向的时候，一开始你可以把地区 A 放到任何一个地方，接下来地区 B 就只能放到 A 的左侧 (A 的西方)，或者右侧 (A 的东方)，但是无论放到哪一侧都无法产生循环东西两方的方位关系。同理，对于 4 个地区的情况也是类似的。因此，我们可以确定这 4 个地区不在同一个水平面上。所以，“小世界安立图” (图1) 把它们放到同一个水平面上是一个重大错误。

接着，佛陀说“南北二方。亦复如是。”思考一下，是什么样的空间结构可以导致东西连通和南北连通？我们在这里不假设佛陀的时空观结构，如果我们只考虑小于或者等于 3 个维度的空间结构⁸，由于前面否定了 2 维空间的可能性，那么这 4 个地区也就只能分布在某个巨大的 3 维立体物的表面，因为只有这种情况才允许方位循环。

那么，这个巨大的 3 维立体物是立方体呢？还是球体？还是其他形状？佛陀没有明说。为了配合古人“天圆地方” (地平说) 的观点，我们在这里假设是正立方体，基于上面分析的循环关系约束，不失一般性的，4 个地区分别分布在前后左右四个面上，我们也暂时不考虑南北循环关系。

同时，根据太阳绕着大地在天空转的观测经验和配合古人认为的“天圆地方” (地平说)，我们

⁸事实上，在没有其他证据的情况下，我们应尽量遵循从古至今人们在日常生活和生产中所形成的，关于空间结构为 3 维的认知。

假设太阳围绕着上面那个正立方体旋转，我们且看下一段节选于《起世经卷第十·最胜品第十二之余》的经文：

复次诸比丘。若阎浮提洲日中。于弗婆提洲则日没。其瞿陀尼洲日出。郁多罗究留洲正夜半。若瞿陀尼洲日中。其阎浮提洲日没郁多罗究留洲日出。弗婆提洲夜半。若郁多罗究留洲日中。其瞿陀尼洲日没。弗婆提洲日出。阎浮提洲夜半。若弗婆提洲日中则郁多罗究留洲日没。阎浮提洲日出。瞿陀尼洲夜半。[13]

这一段以日出日落来描述这 4 个地区在时间上的循环交互关系。在这里我们要强调一个古今都熟知的日常观测经验，即，每一天，太阳从东面的地平线升起（日出），中午的时候跑到天空中间（头顶上方，但不一定是垂直上方），傍晚从西面的地平线落下（日落）。根据这个常识和我们前面所做的模型假设及这段经文的描述，我们看看究竟能得出怎么样的结论，请看图2：

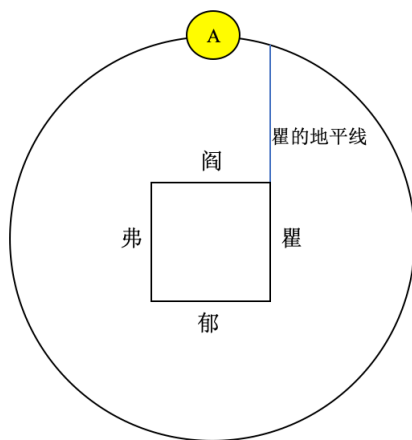


图 2: 假想的太阳轨道运行图

图2为鸟瞰图，即从正立方体的地球（前文已假设其为正立方体）的北极上空向南极方向看，中间的正方形表示地球，外面大圆表示太阳的运行轨道，即绕着赤道旋转，4 个地区分布在环绕赤道的 4 个面上。显然，当阎浮提洲日中时，即太阳运行到 A 点位置时，郁多罗究留洲确实正在半夜，但是瞿陀尼洲并没有如经文上所说处于日出状态，只有当太阳处于运行轨迹（大圆）和瞿陀尼洲的地平线交叉点的位置才是日出状态。而弗婆提洲早就日落超过 6 个小时，和经文的描述产生了矛盾。

我们再假设太阳的运行轨迹（图2中大圆）正好外切于正方形，即太阳运行时可以撞击地球的 4 个角，那么处在弗婆提洲正中间的人就会发现，中午的太阳明显比日出和日落的时候大很多，而事实上无论是古代还是现代并没有这种稳定的观测结果。综合以上两点，我们可以认为，即便太阳绕着地球转，地球也不可能是正立方体。能符合经文描述的 3 维物体，其形状只能是球体或者接近球体。

3 地下层级

有了这个结论之后，我们再返回到这一节一开头的那段没有解释完的经文：

诸比丘。此大地厚四十八万由旬。边广无量。诸比丘。此之大地住于水上。水住风上。风依虚空。诸比丘。此大地下所有水聚。彼水聚厚六十万由旬。边广无量。彼水聚下所有风聚。彼风聚厚三十六万由旬。边广无量。[12]

读了这一段，我们现在清楚了，这里所谓的上下关系，其实是地球土地内部的上下关系。而这一段关于地球内部的描述，其意思是“在固态聚合物（大地）下有液态聚合物（水聚），在液态聚合物下方有气态聚合物（风聚）。”古文的金木水火土是不能直接等价于日常生活中的金属、木头、液态水、明火和泥土，需要根据上下文去推测。

这一段经文提到“风依虚空”，我们在这里综合分析一下“风依虚空”的含义。首先，在这里没有像前面“此之大地住于水上”和“水住风上”那样表示“风住虚空上”，和前面的方位逻辑不一致。因此我们认为，“风”（即风聚）和“虚空”之间没有任何上下的方位关系。又根据前面分析可知，这一段是地球内部情况的描述，这里的上下关系也就是地球的内（下）外（上）关系。因此，“风”（即风聚）和“虚空”之间没有内外关系。其次，此段经文对“大地”、“水聚”、“风聚”，都用“边广无量”来描述，而对“虚空”没有这种表述（在这里我们暂时不讨论为什么“边广”是“无量”，而不是某个具体的数值），同时也没有“虚空聚”或者“空聚”等概念，因此我们认为“虚空”和“大地”、“水聚”、“风聚”这三者之间并非同类。最后，地球内部压力巨大，根本就不可能产生无压强的真空（虚空），必须有填充物。综上所述，我们认为“风依虚空”的意思就是“风（聚）直接悬浮于虚空中”。又根据“此之大地住于水上。水住风上。风依虚空”可推知，经文间接表明地球直接悬浮于虚空中。

地球圈层名称			深度 (千米)	密度 (克/立方厘米)	物质状态	
一级分层	二级分层	传统分层				
外 球	地壳		地壳	0 - 33	2.6 - 2.9	固态物质
	外 过 渡 层	外过渡层 (上)	上地幔	33 - 980	3.2 - 3.6	部分 熔融物质
		外过渡层 (下)	下地幔	980 - 2900	5.1 - 5.6	液态-固态物质
液态层	液态层	外地核	2900 - 4700	10.0 - 11.4	液态物质	
内 球	内过渡层	过渡层	4700 - 5100	12.3	液态-固态物质	
	地核	内地核	5100 - 6371	12.5	固态物质	

表 1: 固体地球结构表 [4]

至此，我们有理由相信佛经描述了地球内部情况，即结构从上到下由三个物质状态层次组成，分别是固态的土地，液态的聚合物及气态的聚合物。同时，根据“此大地厚四十八万由旬”、“彼水聚厚六十万由旬”和“彼风聚厚三十六万由旬”这三句经文，即可知这三层物质的厚度其和为 144 万由旬，比例为 4:5:3。再根据现代地理学中地球深度为 6371 千米的知识 [4]，我们可以换算出 1 由旬约为 $6371000 \div 1440000 \approx 4.42$ 米。因此佛经所表述的地底固态层和液态层的分界面按比例在地下 2124 千米处，液态层和气态层的分界面按比例在地下 4778 千米处。从现代地理学 [4]（如表1所示）我们可以知道，地下深处 980 千米到 2900 千米为下地幔，其物质状态为固态到液态的过渡层，而根据佛经推算出来的第 1 个物质状态分界面 2124 千米正好处于这个范围大约中间的位置。又根据现代地理学 [4]（如表1所示），地下深度 4700 千米到 5100 千米为液态到固态的过渡层，也为地核中外地核和内地核的过渡层。而佛经推算出的第 2 个物质状态分界面，即 4778 千米也在这个范围内。

在这里，佛陀对于地球内部的物质圈层划分基本符合现代地理科学的一级分层，即“外球-液态层-内球”。同时，我们知道佛陀在这段经文描述中没有根据地震波的横纵波速度的测算来划分圈层 [4]，而是根据物质状态进行划分。这导致在具体分界面上略有不同，但也在现代科学认可的过渡层里。

在这里大家可以注意到一点，佛陀认为地球的内核是气态，而现代科学主流一般认为是固态，这是不同的观点。而实际情况是，地球内核因为无法直接探测，科学界对地球内核存在何种物质及物质形态都有不同的看法，目前可塑性固态假说占据上风。此外，根据现代物理学可知，等离子体 [8] (plasma) 又叫做电浆，是由部分电子被剥夺后的原子及原子团被电离后产生的正负离子组成的离子化气体状物质。它广泛存在于宇宙中，常被视为是除去固、液、气外，物质存在的第四态。我们认为按照这个离子化气体状的定义，佛经中的“风聚”也可以是等离子体，而非一般的气态物质。因此，倘若地球的内核是具有固态物质密度的等离子体，则两者之间并不矛盾。那么，最终的结论究竟是什么，我们有待科学的进一步发展。

4 结论

结论 4.1 古人“天圆地方”(地平说)的假设与佛经描述之间存在矛盾。佛陀完全知道我们所在的土地分布在一个 3 维球状物体的上面，即地球是圆球体。

结论 4.2 佛陀对地球的内部结构、物质形态等有精准的认识，对地底物质形态的分层结构有准确的数值比例描述。

结论 4.3 佛陀对于地球内部的物质圈层划分基本符合现代地理科学的一级分层，即“外球-液态层-内球”，如图 3 所示⁹。同时，我们知道佛陀并没有根据地震波的横纵波速度的测算来划分圈层 [4]，而是根据物质状态，即“某种直观的感知”作为划分依据。

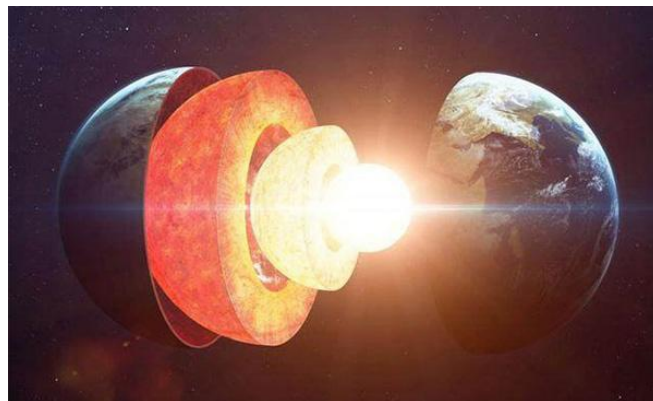


图 3: 地球内部结构, 图片来源: 互联网

结论 4.4 我们换算出 1 由旬约为 4.42 米，而非通常认为的 11.2 千米 [7]。

5 讨论

问: 既然佛陀知道地球是球体，为什么不直接表明?

答: 我们认为其原因有以下几点:

⁹注意，佛经在此处并无阐述最外层的地壳，而是将其和大部分地幔结合在一起共同形成“大地”。此概念近似于现代地理学中地球圈一级分层中的外球 [4]。

- (1) 在 2500 多年前，在几乎所有人都相信地平说的年代，直接表述大地处于一个球体表面必然会引起巨大的纷争和强烈的质疑。这又必然会严重影响佛陀教化众生的主要工作，甚至导致不可预计的险恶后果。譬如：文艺复兴时期意大利思想家、自然科学家、哲学家和文学家乔尔丹诺·布鲁诺（1548-1600）[2] 因为勇敢地捍卫和发展了哥白尼的太阳中心说，并把它传遍欧洲。在他所处的时代中，这种学说使其成为了风口浪尖上的人物，他于 1592 年被捕入狱，最后被宗教裁判所判为“异端”。1600 年 2 月 17 日，被烧死在罗马鲜花广场。
- (2) 地圆学说 [3] 并非在文艺复兴时期才提出来，实际上，早在公元前 6 世纪，古希腊数学家毕达哥拉斯提出这一概念。约公元前 3 世纪，生活在亚历山大的科学家埃拉托色尼用几何学方法确立了地球的概念。因此，2500 多年前就知道地球是圆的，这并不稀罕，但确实属于一种先知先觉。
- (3) 在《首楞严经》中，佛经有极高度疑似暗示我们生活的世界是一个球体：

而阿那律见阎浮提，如观掌中庵摩罗果；[1]



图 4: 左图为“而阿那律见阎浮提，如观掌中庵摩罗果”[1]；右图为庵摩罗果，中国称为余甘子。

如图4中左子图所示。在这里，根据我们前文的分析，“阎浮提”间接代指我们人类所生活的土地（地球），而庵摩罗果 [5] 是一种印度果实的名字，中国称为余甘子，如图4中右子图所示。在这里，用庵摩罗果来比喻地球是非常传神和准确的。首先，两者都是球体。其次，庵摩罗果的果皮、果肉和果核分别依次对应地球内部结构传统分层的地壳、地幔和地核。最后，庵摩罗果（如图4中右子图所示），其果肉厚度和果核的半径比例与地球的地幔厚度和地核的半径比例相近，也再一次呼应了前文“小世界”一节（第3节）中关于地球内部结构的经文分析。

其次，通过前文的分析可知，依旧存在很多尚未被解决的问题。譬如，根据前文关于由旬的换算，我们知道“须弥山王”的高度 84000 由旬约为 $84000 \times 4.42 = 371.28$ 千米，而众所周知，地球上最高的山是 8848.86 米的珠穆朗玛峰 [6]，其高约为 8.85 千米，远小于“须弥山王”出海面部分的 371.64 千米。这表明“须弥山王”不能等同于我们常识中的任何一座在地球上的山。那么，“须弥山王”究竟是什么，它又在地球的哪里？此外，前面所提的四大部洲真的在地球上吗？如果是，又如何验证？它们又在哪里呢？我们前面关于由旬的换算合理吗¹⁰？

最后，在以后的文章中，我们会对这些问题提供可验证的且符合逻辑一致性（与本文内容可互相印证）的解答及更多包括经文内在描述逻辑印证和相关科学观测验证。读者将见证更多关于佛经宇宙观描述中，具备“时代超越性”的、能“互相印证”且形成环环相扣“证据链”的内容。

¹⁰值得注意的是，如果这个换算是合理的（在以后的文章中可以逐步检验），从逻辑上看，佛陀还知道地球半径的长度。但目前我们并不把“佛陀知道地球半径的长度”作为本文的结论，因为我们是根据已知地球半径换算出度量单位“由旬”的长度。

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- [5] 百度百科. 庵摩罗果.
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