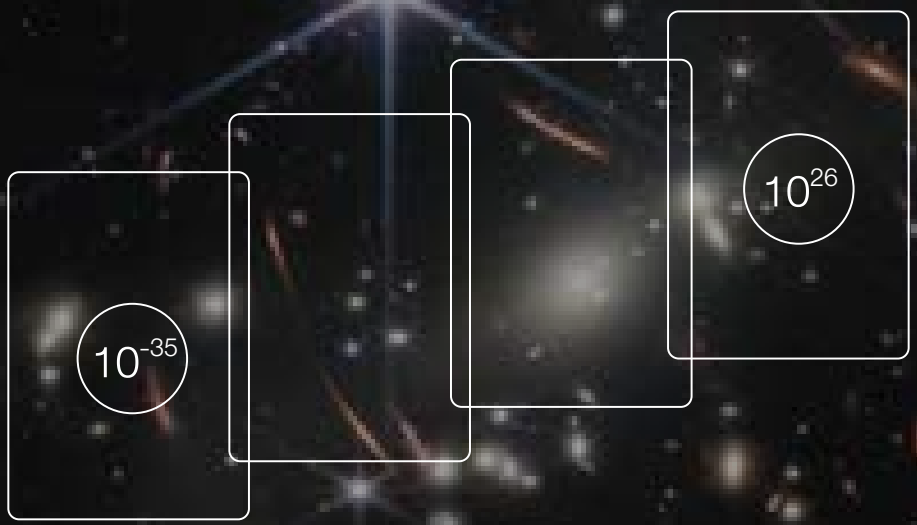
POWERS OF TEN

From Atoms to the Universe



www.NARIT.or.th

RULES

1. Choose **one set** of cards, which can be selected by color as follows:

   Red : Interstellar to Galactic

   Orange : Earth to Solar System

   Yellow : Everyday Objects to Space

   Green : Everyday Objects to Molecular

   Blue : Molecular to Subatomic

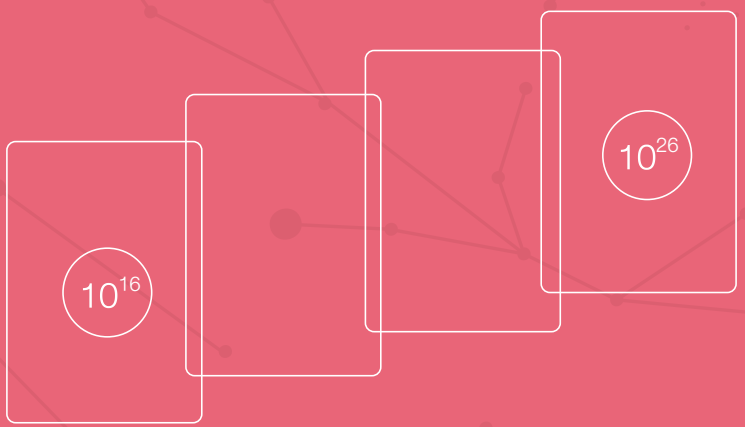
2. Shuffle the cards (without looking at the back side). Arrange the cards from the smallest on the left to largest on the right until you finish the set.

3. Once you have arranged the cards, flip each of them over to check the '- ANSWER -' side. Larger objects should have bigger exponent.

4. You can try other set, or combine all the sets to arrange everything from Atoms to the Universe.

Interstellar to Extragalactic

Our solar system is just one star system among the billions of stars in our galaxy, which is one of the many billions of galaxies in the universe, all coming together in a cluster, forming a vast and expansive structure beyond what any one human can imagine.



Answer key explanation

- ANSWER -

Object **Princess Sirindhorn AstroPark**

Explanation It is the National Observatory of Thailand and the headquarters of the National Astronomical Research Institute. It is located in Don Kaew Subdistrict, Mae Rim District, Chiang Mai Province.

Circle represents the reference size.

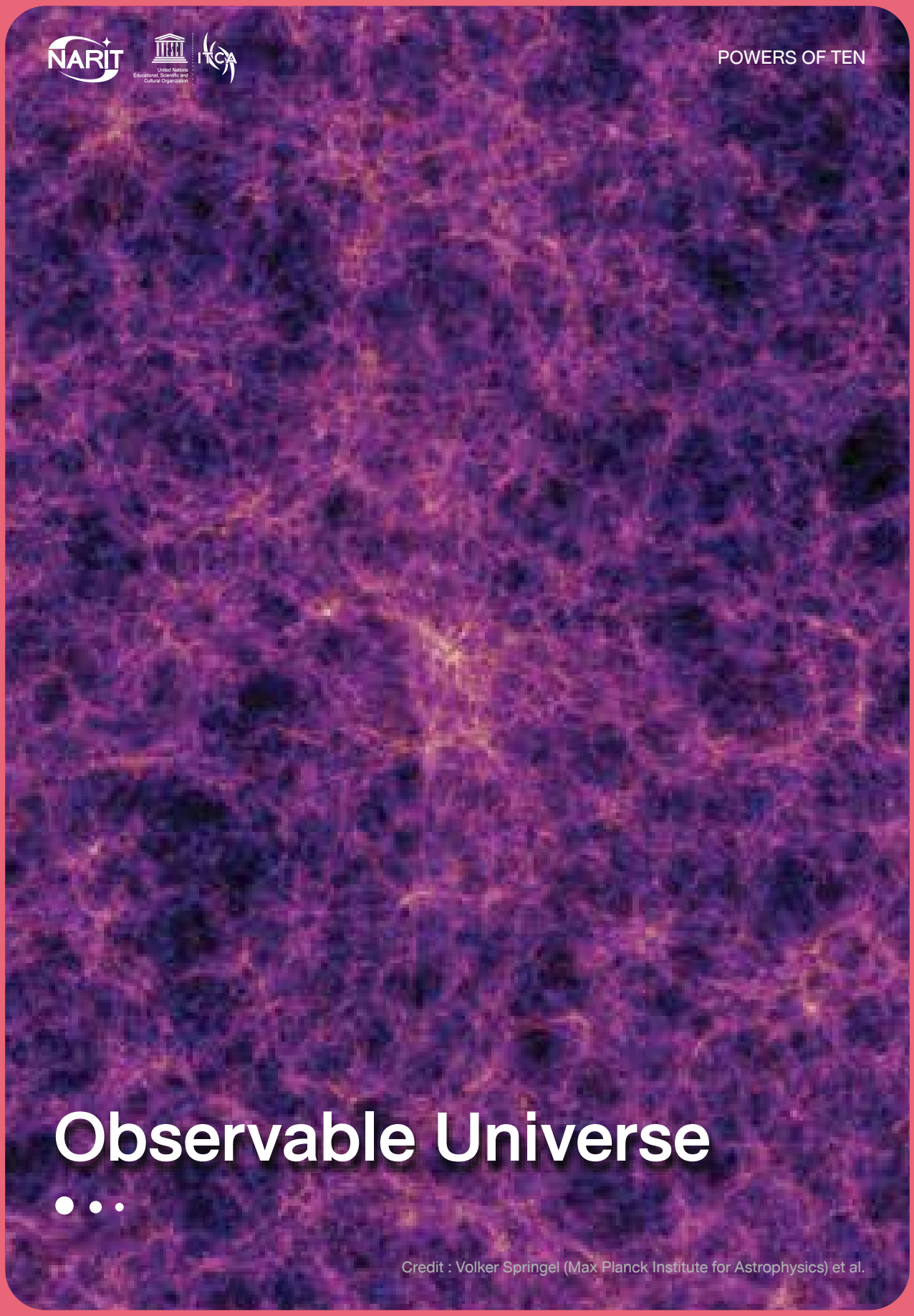
We are scaling down the object to the size of this circle.





Previous Size representation of the next smaller object in the sequence if the object is scaled to the reference circle.

Next Size representation of the next larger object in the sequence if the object is scaled to the reference circle.



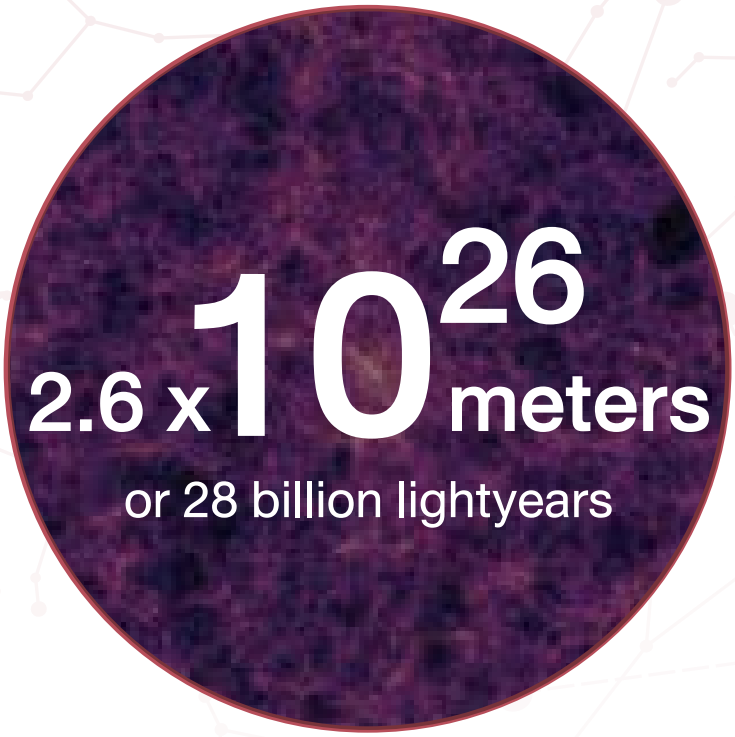
Observable Universe

Credit : Volker Springel (Max Planck Institute for Astrophysics) et al.

- ANSWER -

Observable Universe

The Observable Universe is the region of universe at which there is enough time for the light to have reached us. Its radius is equal to the current age of universe in lightyears.



40 mm.
(Ping Pong Ball)

Previous
Laniakea Supercluster

•
0.7 mm.

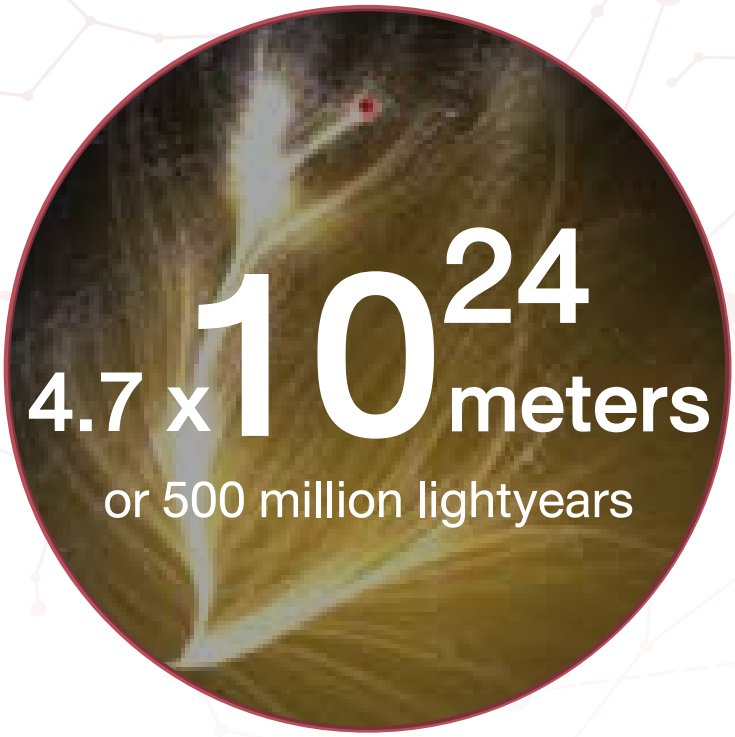


Credit : Nature Video

- ANSWER -

Laniakea Supercluster

Laniakea Supercluster is an extremely large cluster of galaxies, including our own, that is measured to be moving along the same gravitational flow.



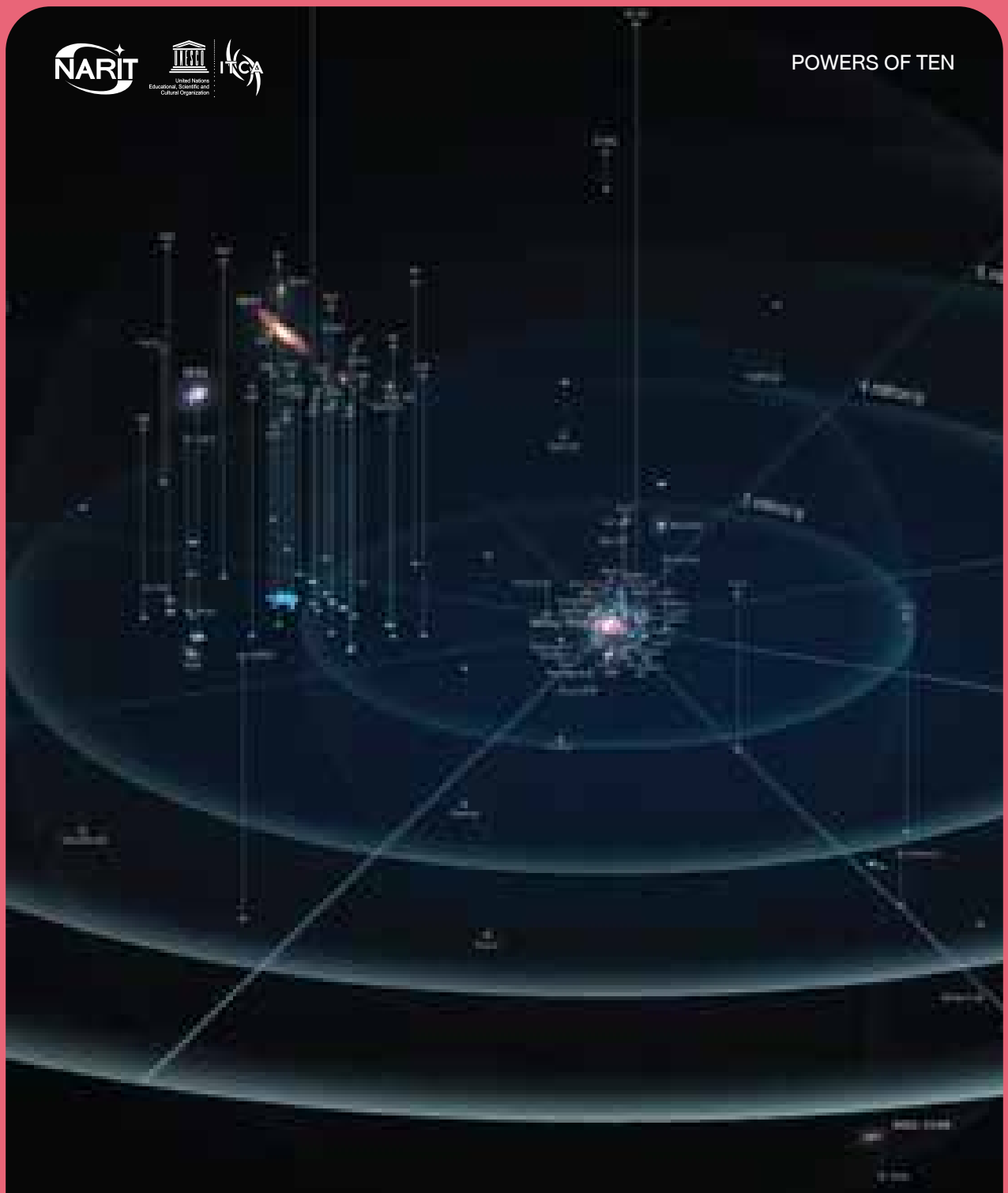
40 mm.
(Ping Pong Ball)

Previous
Local Group of Galaxies

•
0.8 mm.

Next
Observable Universe

Ceiling



Local Group of Galaxies

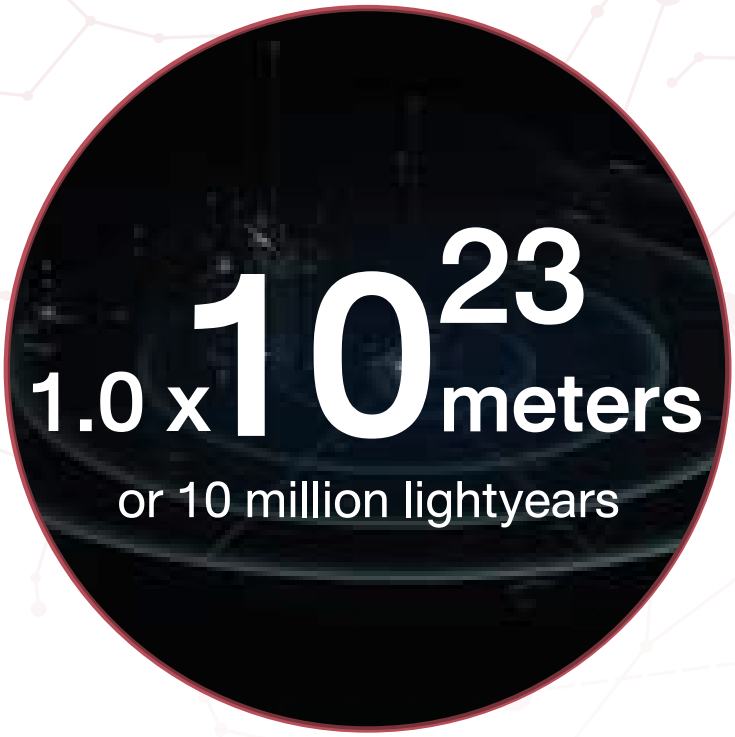
• • •

Credit : Antonio Ciccolella

- ANSWER -

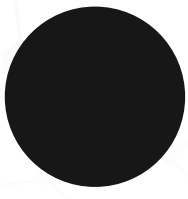
Local Group of Galaxies

The Local Group of Galaxies is the name of clusters of galaxies that include the Milky Way and over 54 nearby galaxies. It contains around a trillion Solar Mass.



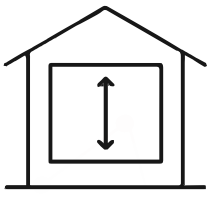
40 mm.
(Ping Pong Ball)

Previous
Distance to Andromeda Galaxy

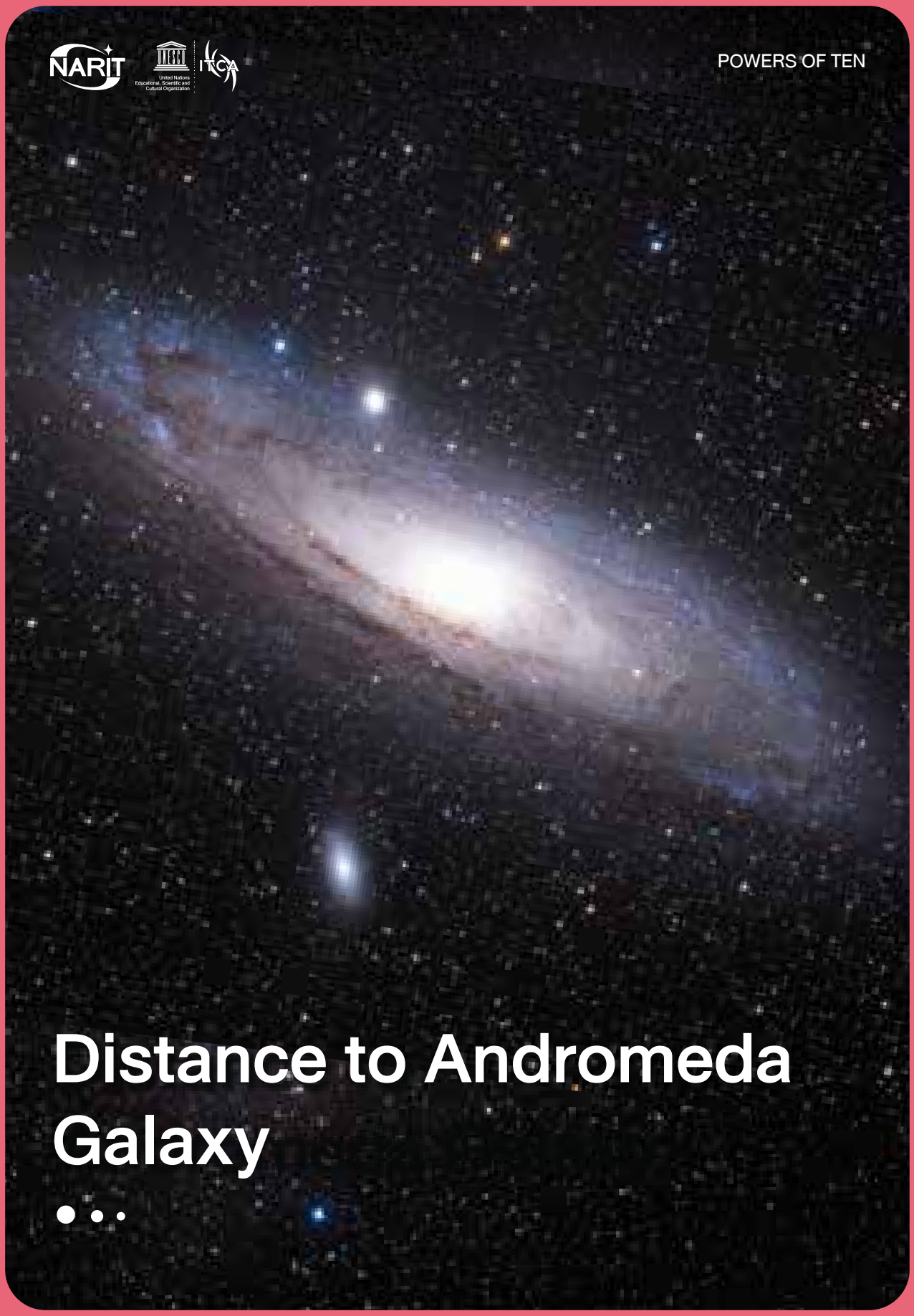


10.0 mm.

Next
Laniakea Supercluster



Ceiling



Distance to Andromeda Galaxy

- ANSWER -

Distance to Andromeda Galaxy

Andromeda Galaxy is the closest neighboring galaxy to our own. It actually spread out in an area 6 times larger than the full moon in the sky, but we can only observe a faint fuzzy area near its galactic center.



40 mm.
(Ping Pong Ball)

Previous
Milky Way Galaxy

1.5 mm.

Next
Local Group of Galaxies

Soccer Ball



Milky Way Galaxy

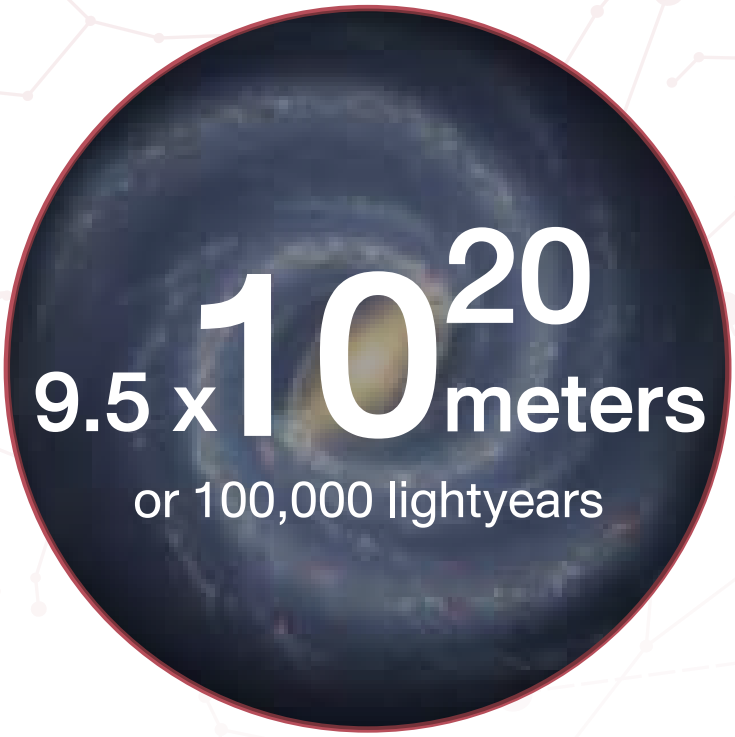
●••

Credit : NASA

- ANSWER -

Milky Way Galaxy

The Milky Way Galaxy is the galaxy at which we live in. Its shape is flatten out like a disk with a central bulge in the center. The solar system is but one lone star situated halfway along one of the arms in the disc.



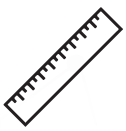
40 mm.
(Ping Pong Ball)

Previous
Distance to Betelgeuse

.

0.3 mm.

Next
Distance to Andromeda Galaxy



Meter stick



Distance to Betelgeuse

●••

- ANSWER -

Distance to Betelgeuse

Betelgeuse is a red giant nearing the end of its lifetime as a massive star before eventually exploding into a supernova. We can find Betelguese along the right shoulder of Orion constellation.



40 mm.
(Ping Pong Ball)

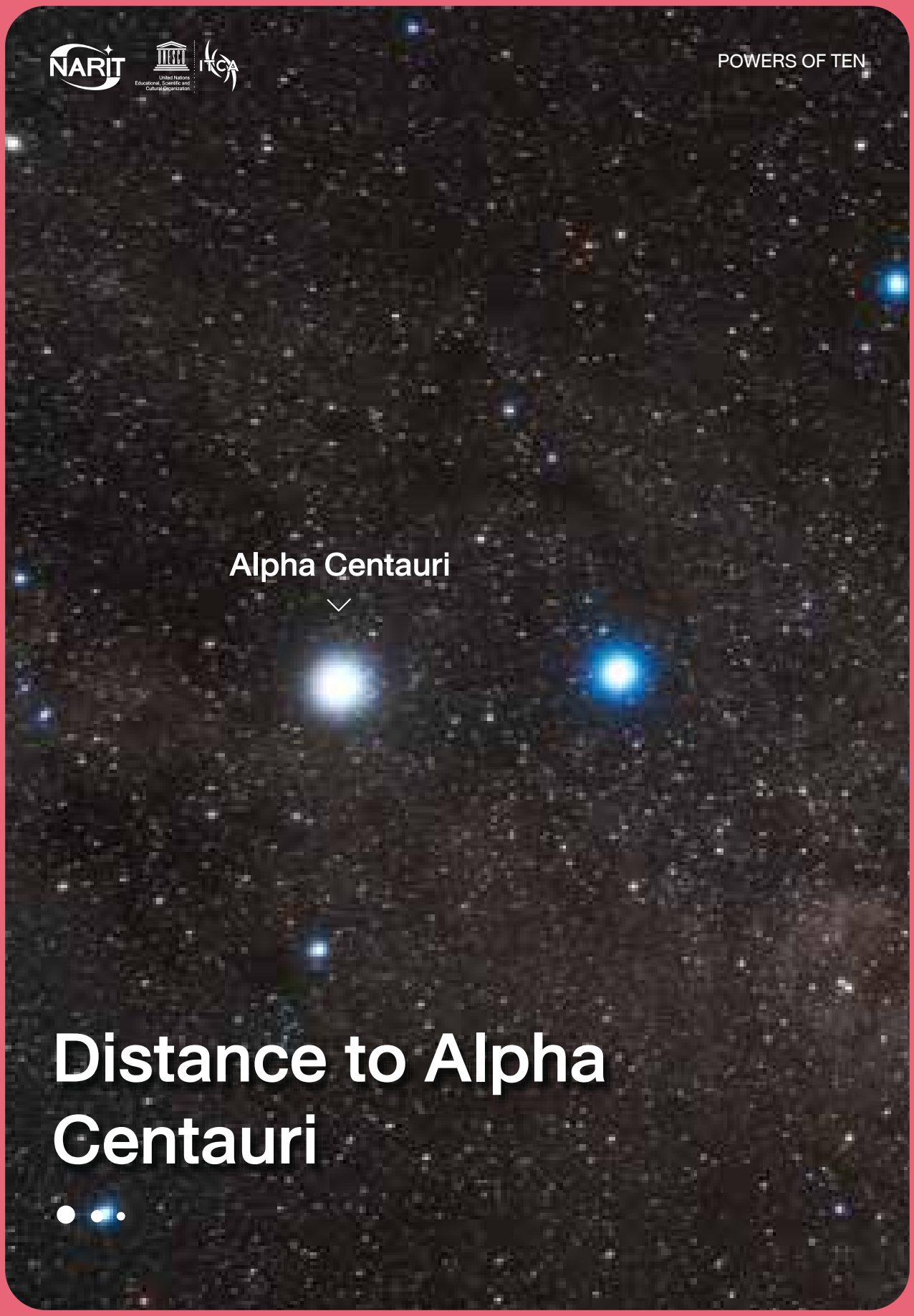
Previous
Distance to Alpha Centauri

Next
Milky Way Galaxy

0.2 mm.



Double storey house



Distance to Alpha Centauri

- ANSWER -

Distance to Alpha Centauri

Alpha Centauri system is the closest star system to our own. It is located about 4.4 light years away, consisting of Alpha Centauri A (Rigil Kentaurus), Alpha Centauri B (Toliman), and another red dwarf named Proxima Centauri orbiting around the binary pair.



40 mm.
(Ping Pong Ball)

Previous
Diameter Oort Cloud

Next
Distance to Betelgeuse

•

0.6 mm.



Double storey house

Earth to Solar System

Earth is one of the planets in our solar system, which consists of various planets and their satellites. Humans have only begun exploring our 'home' in the past century, mostly through robotic missions, while humans themselves have traveled only as far as our moon.



Answer key explanation

- ANSWER -

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10^3

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Previous Size representation of the next smaller object in the sequence if the object is scaled to the reference circle.

Next Size representation of the next larger object in the sequence if the object is scaled to the reference circle.



Diameter of Oort Cloud

●••

Credit : Pablo Carlos Budassi

- ANSWER -

Diameter of Oort Cloud

Oort Cloud is a large area situated about 2,000 to 20,000 AU away from the Sun. This is the area which long period comets most of their time in. We expect there to be over a trillion comets currently occupying this region.



40 mm.
(Ping Pong Ball)

Previous
Distance to Voyager 1

0.1 mm.

Next
Distance to Alpha Centauri



Soccer Ball



Distance to Voyager 1

●••

Credit : NASA

- ANSWER -

Distance to Voyager 1

Voyager 1 is the furthest man-made object ever sent from Earth. It was launched in 1977 to study the outer solar system and is the first probe to have reached heliopause entering interstellar region in 2012.



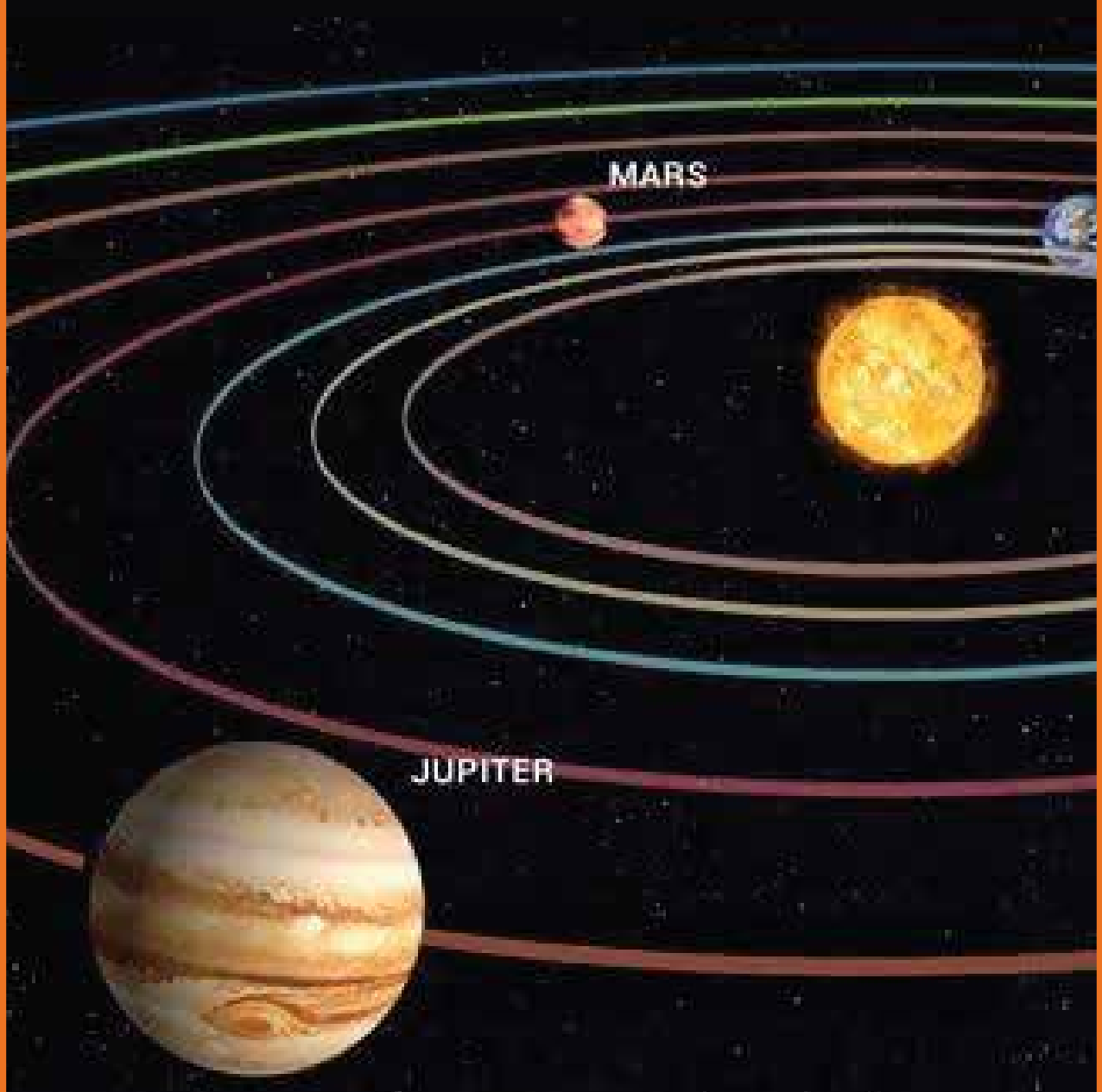
40 mm.
(Ping Pong Ball)

Previous
Diameter of Jupiter Orbit

3.0 mm.

Next
Diameter of Oort Cloud

Tennis Court



Diameter of Jupiter Orbit

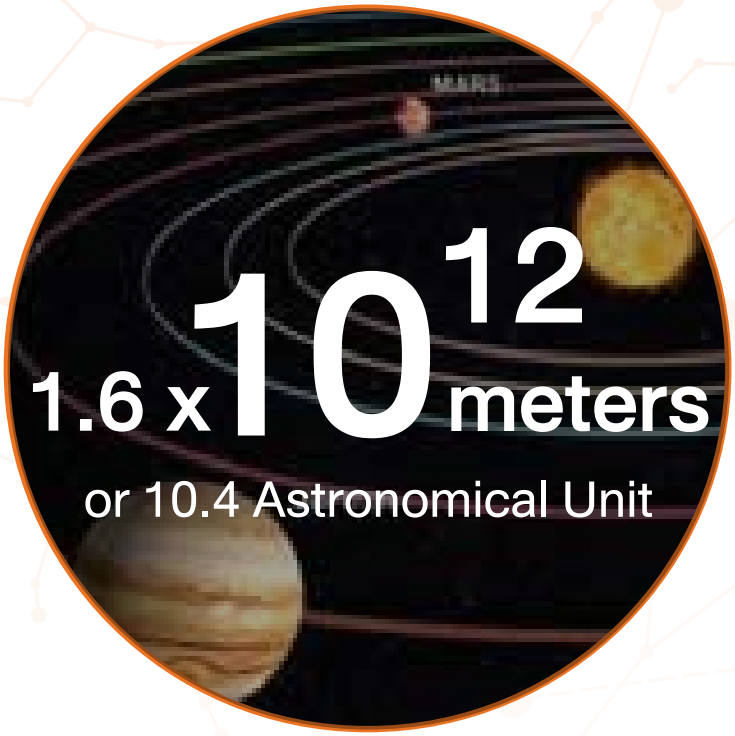
• • •

Credit : THE NINE PLANETS

- ANSWER -

Diameter of Jupiter Orbit

Jupiter is the most massive planet in the solar system. It has more than 2.5 the mass of all the rest of the planets combined.



40 mm.
(Ping Pong Ball)

Previous
Distance to the Sun

4.0 mm.

Next
Distance to Voyager 1

Gym Ball



Distance to the Sun

●••

- ANSWER -

Distance to the Sun

The average distance of Earth's orbit around the Sun can be used to calculate distance to many other nearby planets and stars. For this reason, we often define this unit of distance as "Astronomical Unit".



40 mm.
(Ping Pong Ball)

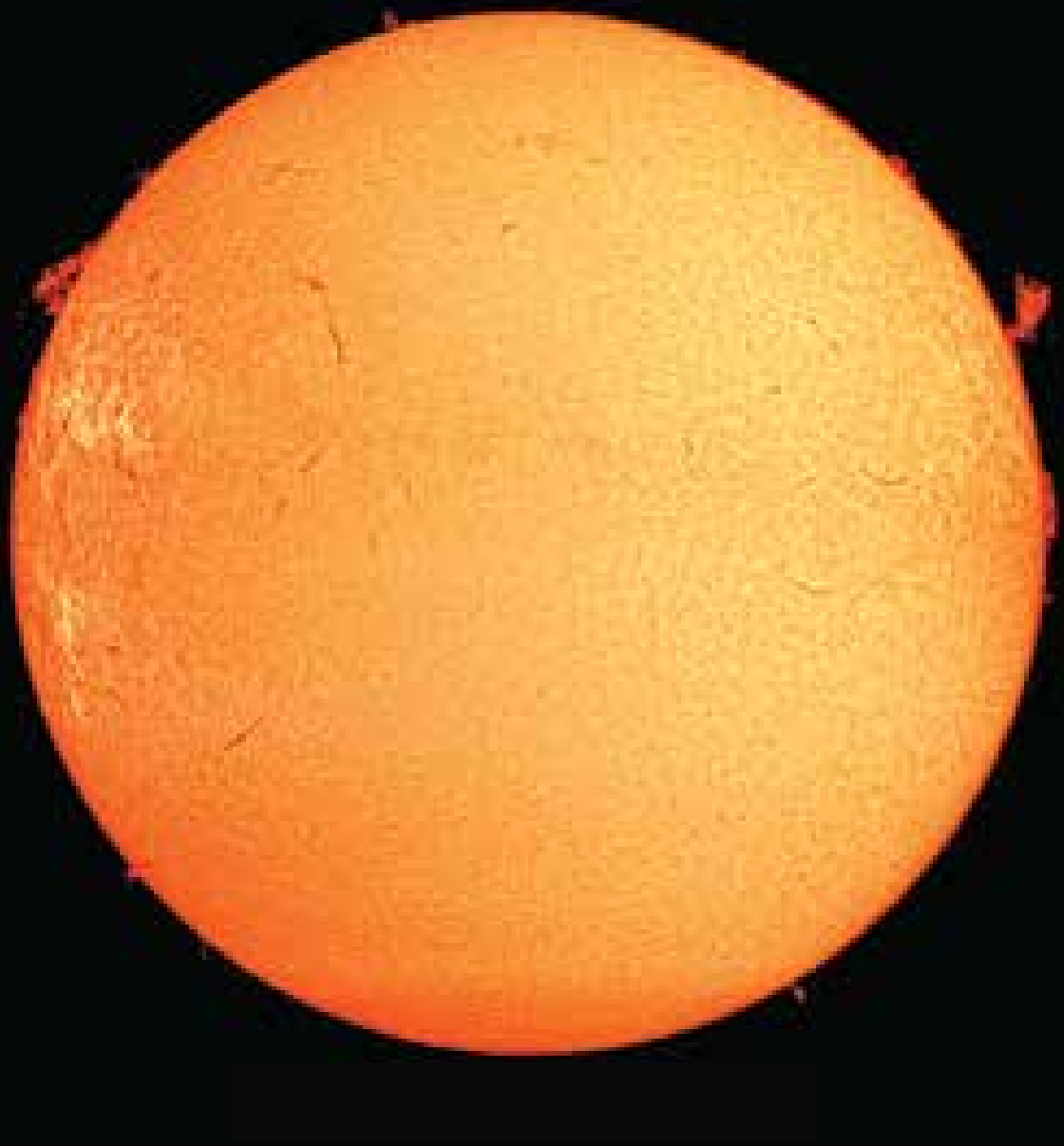
Previous
Diameter of the Sun

•

0.4 mm.

Next
Diameter of Jupiter Orbit

Gym Ball



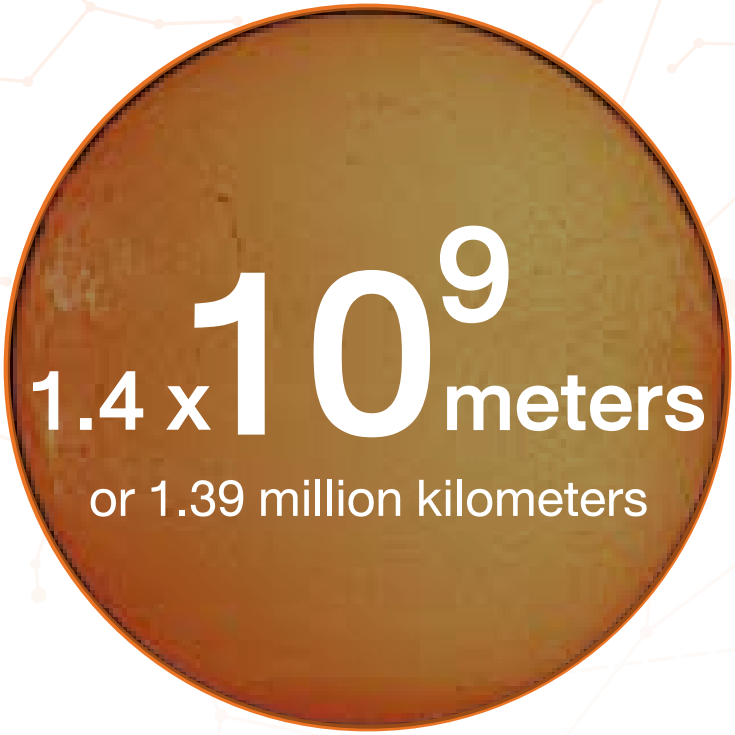
Diameter of the Sun

●••

- ANSWER -

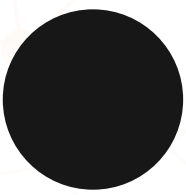
Diameter of the Sun

The only star in the Solar System and the main source of energy to most lives on Earth. For the past five billion years, an ongoing thermonuclear explosion inside its core has been the main source of its energy.



40 mm.
(Ping Pong Ball)

Previous
Distance to the Moon



10.0 mm.

Next
Distance to the Sun



Giraffe



Distance to the Moon

●••

Credit : Apollo 8

- ANSWER -

Distance to the Moon

The distance to the Moon is the furthest distance any man has ever traveled. This was achieved by the Apollo astronauts and it took them over three days to get there.



40 mm.
(Ping Pong Ball)

Previous
Size of Earth

•

1.0 mm.

Next
Diameter of the Sun



Soccer Ball



Diameter of Earth

●••

Credit : NASA/Apollo 17 crew

- ANSWER -

Diameter of Earth

Earth is the only planet we call home. It is the largest terrestrial planet in the solar system. So far, this tiny rock in space is the only place in the entire universe that we currently know to harbor life.



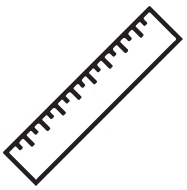
40 mm.
(Ping Pong Ball)

Previous
Diameter of the Moon



10.0 mm.

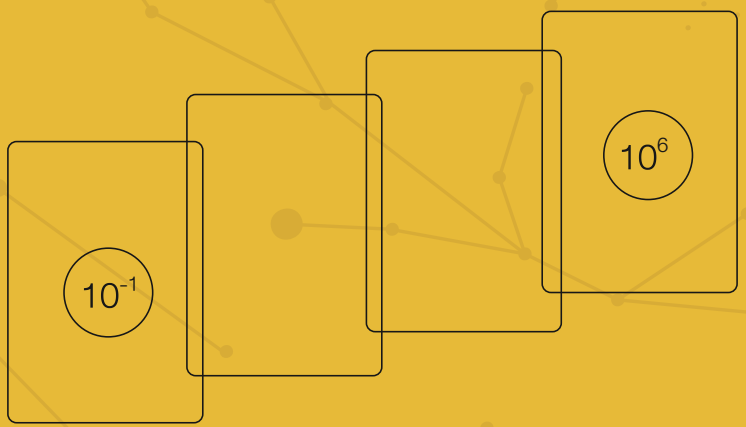
Next
Distance to the Moon



Meter Stick

Everyday Objects to Space

We can find every person we know, the places we have been, and everything we encounter in our daily lives within the thin region between the Earth's crust beneath our feet and the space above our atmosphere. The highest mountains, the deepest oceans, and the farthest distances that humans have traveled all occur within this region.



Answer key explanation

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Next Size representation of the next larger object in the sequence if the object is scaled to the reference circle.



Diameter of the Moon

●••

- ANSWER -

Diameter of the Moon

The Moon is the Earth's only natural satellite. The Moon only reflects light from the Sun and the proportion of this sunlit area changes as it orbits around the Earth. Observing these "phases" of the Moon allow us to keep track of period of time which later become known as "Month".



40 mm.
(Ping Pong Ball)

← Previous
Altitude of ISS



5.0 mm.

Next →
Diameter of Earth



Soccer ball



Altitude of ISS

●••

Credit : ISS

- ANSWER -

Altitude of ISS

The International Space Station, or ISS, is the largest man-made structure in space. The ISS is orbiting in the Low Earth Orbit around 400 km from the ground and is maintained by an international collaboration among US, Russia, Japan, Europe, and Canada.



40 mm.
(Ping Pong Ball)

Previous
Altitude of Troposphere

1.3 mm.

Next
Diameter of the Moon

Gym Ball



Altitude of Troposphere

• • •

Credit : NASA/Jeff Williams

- ANSWER -

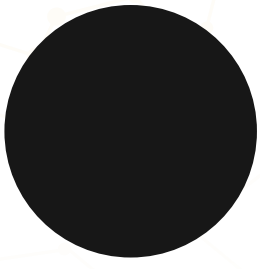
Altitude of Troposphere

The Troposphere is the lowest layer of the atmosphere of Earth. This is where most weather phenomena and the air we breathe can be found. Most commercial airlines skim the top of this layer.



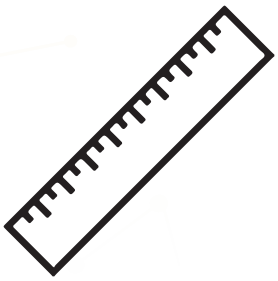
40 mm.
(Ping Pong Ball)

← Previous
Width of Manhattan, New York



14.0 mm.

Next →
Altitude of ISS



Meter Stick



Width of Manhattan, New York

Credit : USGS EROS Data Center

- ANSWER -

Width of Manhattan, New York

Manhattan is the most densely populated area of New York City. This makes this small island one of the densest and busiest urban areas in the world.



40 mm.
(Ping Pong Ball)

Previous
Diameter of FAST, largest radio telescope in the world



5.0 mm.

Next
Altitude of Troposphere



Soccer Ball



Diameter of FAST, largest radio telescope in the world

• • •

Credit : Xinhua

- ANSWER -

Diameter of FAST, largest radio telescope in the world

Five-hundred-meter Aperture Spherical Telescope, or “FAST” is the world’s largest filled-aperture radio telescope located in southwest China. This large aperture allows radio astronomers to study the faintest radio sources from space.



40 mm.
(Ping Pong Ball)

Previous
Diameter of Grand Telescopio Canarias (GTC)

Next
Width of Manhattan, New York

0.8 mm.

Gym Ball



Diameter of Grand Telescopio Canarias (G·TC)

- ANSWER -

Diameter of Grand Telescopio Canarias (GTC)

The Grand Telescopio Canarias (GTC) is the largest single-aperture optical telescope located on the island of La Palma in the Canary Islands.



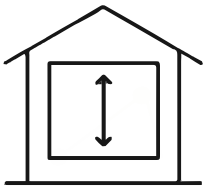
40 mm.
(Ping Pong Ball)

Previous
Diameter of Hubble Space Telescope



9.0 mm.

Next
Diameter of FAST, largest radio telescope in the world



Ceiling



Diameter of Hubble Space Telescope

• • •

Credit : NASA

- ANSWER -

Diameter of Hubble Space Telescope

The Hubble Space Telescope is a space telescope launched into low earth orbit in 1990. It held the title of the largest space telescope in operation until the launch of JWST in 2021.



40 mm.
(Ping Pong Ball)

Previous
Soccer Ball



4.0 mm.

Next
Diameter of Grand Telescopio Canarias (GTC)



Soccer Ball



Soccer Ball

●••

- ANSWER -

Soccer Ball

A standard soccer ball is a spherical object with diameter of about 21 cm. Coincidentally, this is roughly the wavelength of radio waves emitted by hydrogen. Since hydrogen is the most prevalent element in the Universe, making it among the most important wavelength in astronomy.



40 mm.
(Ping Pong Ball)

Previous
Ping Pong Ball



7.0 mm.

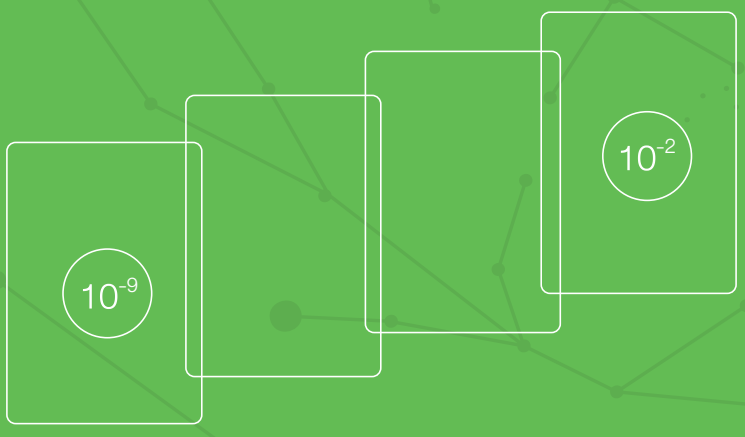
Next
Diameter of Hubble
Space Telescope



Gym Ball

Everyday Objects to Molecular

Life on our planet is composed of cells. These cells can vary in size and have different functions. All of these cells together make up our bodies.



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Next Size representation of the next larger object in the sequence if the object is scaled to the reference circle.



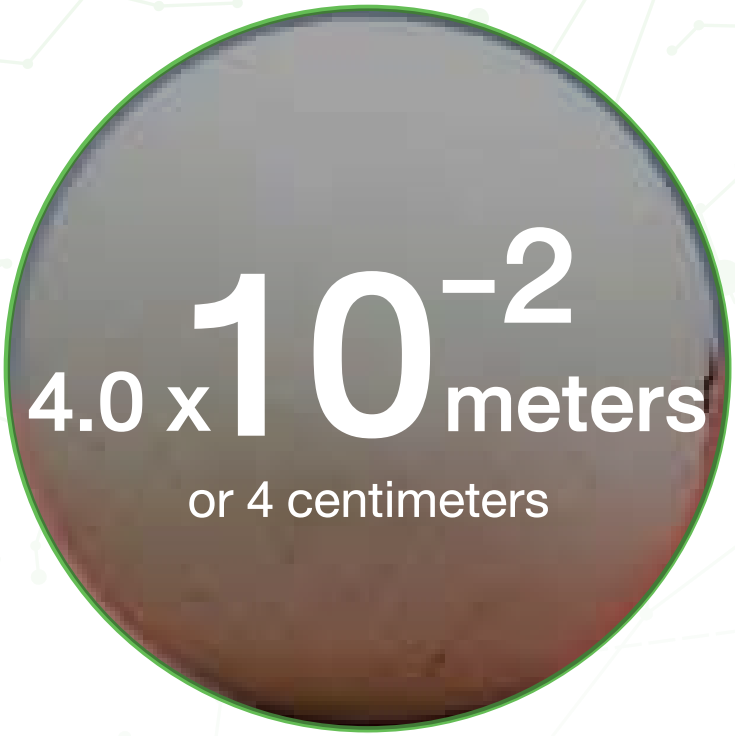
Ping Pong Ball

●••

- ANSWER -

Ping Pong Ball

A standard ping pong ball is a sphere with diameter of 4 cm. The cards in this activity are designed so that this circle below represents exactly the size of a standard ping pong ball.



40 mm.
(Ping Pong Ball)

Previous
Thickness of pencil lead

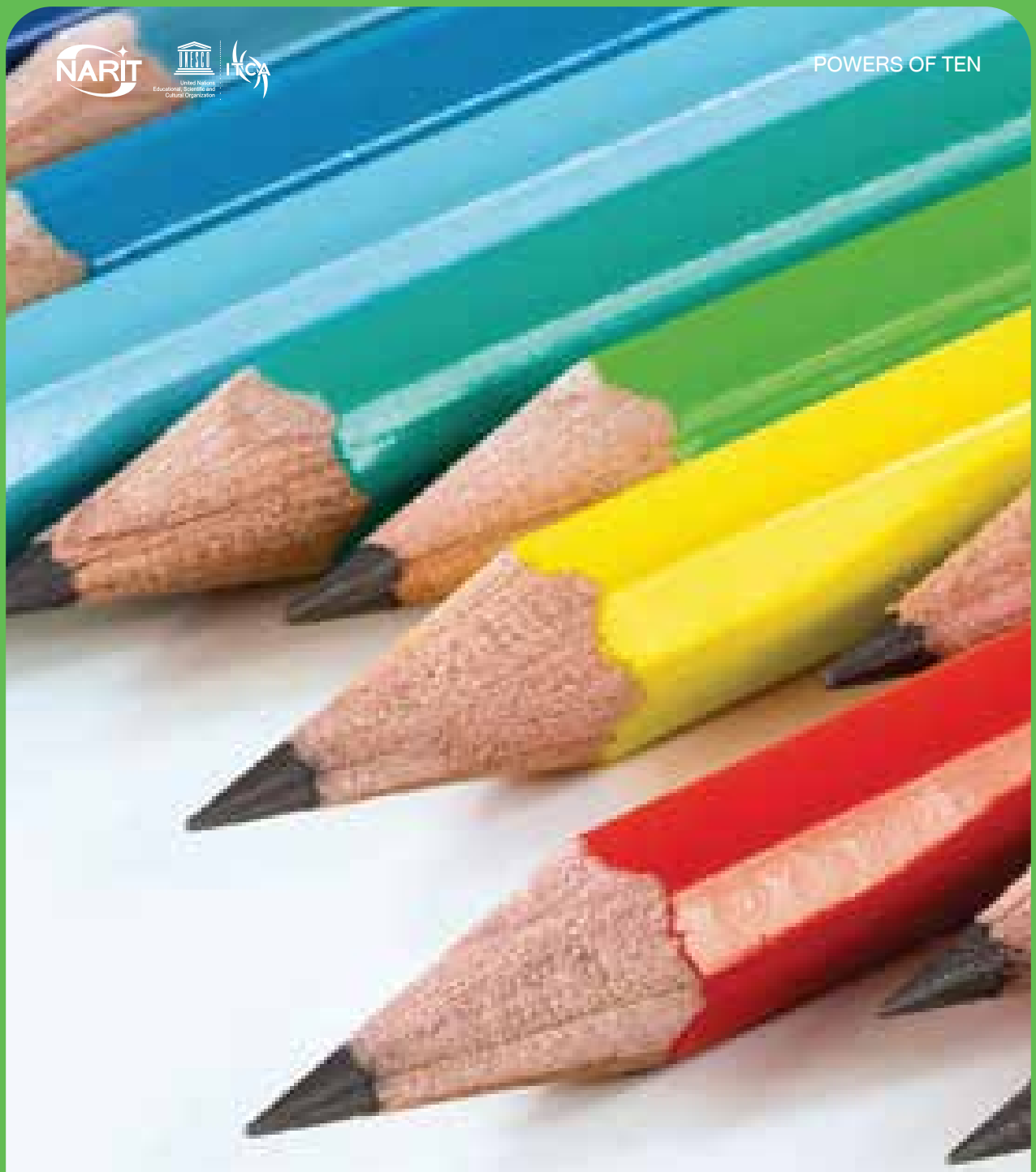


2.0 mm.

Next
Soccer Ball



Soccer Ball



Thickness of pencil lead

●••

- ANSWER -

Thickness of pencil lead

Most pencils are made of graphite which made up from thin graphene sheets loosely held together. As a pencil is dragged across a paper, the graphene sheets slide away, leaving pencil lines that we can see.



40 mm.
(Ping Pong Ball)

Previous
Human ovum

2.0 mm.

Next
Ping Pong Ball

Meter Stick



Human ovum

●••

Credit : D. Phillips/SCIENCE PHOTO LIBRARY

- ANSWER -

Human ovum

Human ovum is the largest cell in the human body and one of the only few cells which can be seen with naked eyes. Every single cell in your body originated from the divisions of this single cell.



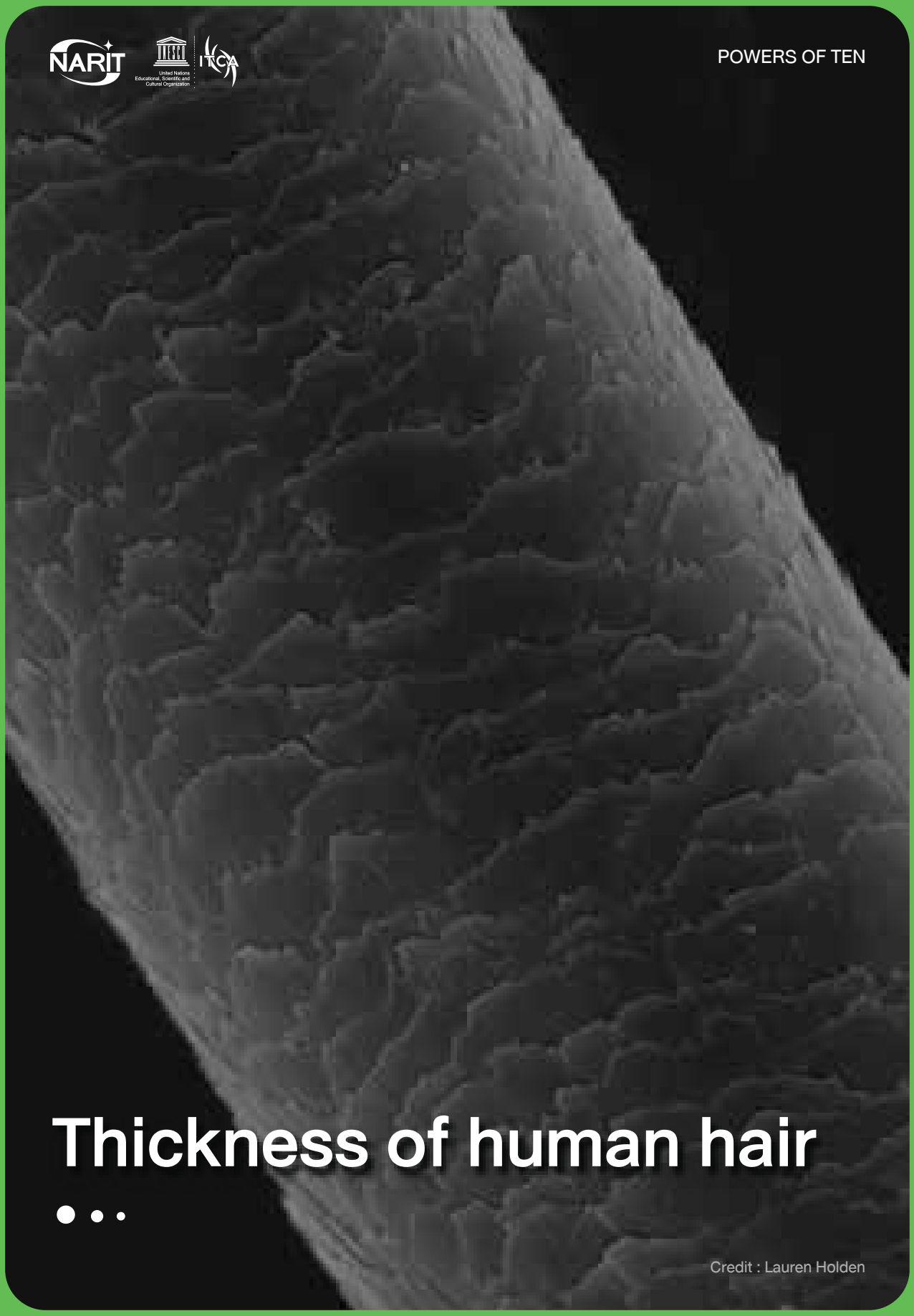
40 mm.
(Ping Pong Ball)

Previous
Thickness of human hair

6.0 mm.

Next
Thickness of pencil lead

Gym Ball



Thickness of human hair

●••

Credit : Lauren Holden

- ANSWER -

Thickness of human hair

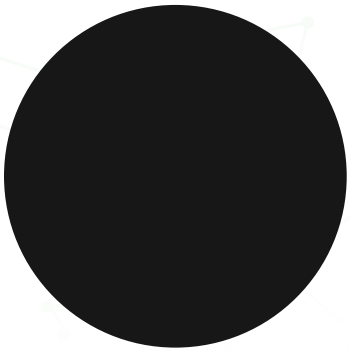
Human hair is a protein fiber made by the cells in the root. Hairs are special characteristic of all mammals. On average a human has around 100,000 hairs on his or her scalp.

1.7×10^{-5} meters

or 17 microns

40 mm.
(Ping Pong Ball)

← Previous
Human red blood cell



19.0 mm.

Next →
Human ovum



Soccer Ball



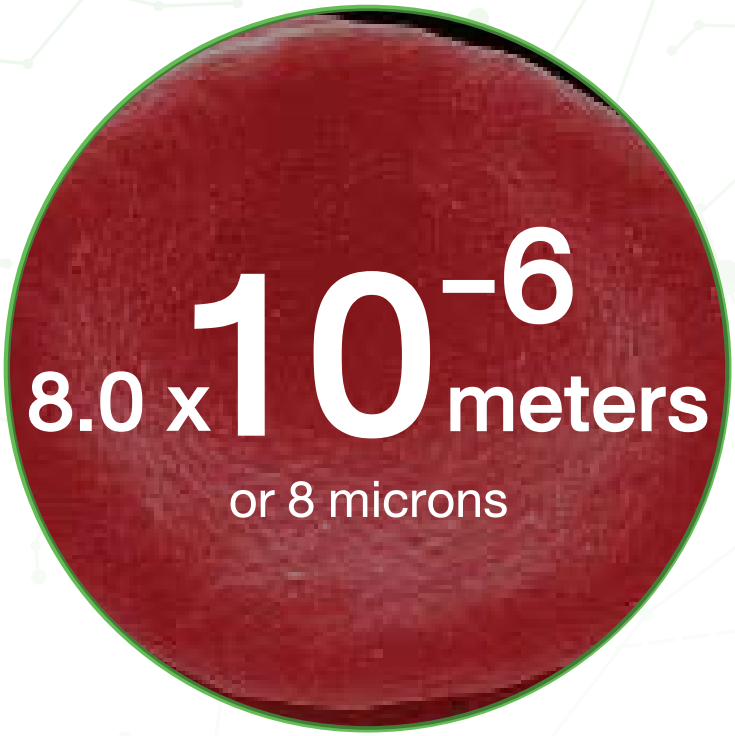
Human red blood cell

• • •

- ANSWER -

Human red blood cell

Human red blood cells are the most numerous cells in our body. Red blood cells perform vital role of delivering oxygen to every part of the body. A drop of blood could contain up to 5 million red blood cells.



40 mm.
(Ping Pong Ball)

← Previous
Wavelength of visible light

Next →
Thickness of human hair



2.0 mm.



Soccer Ball



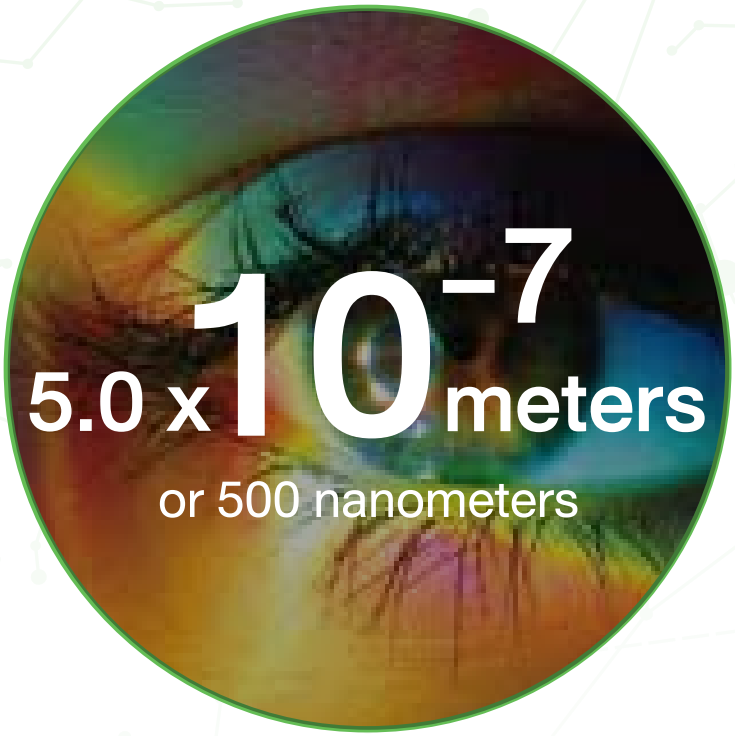
Wavelength of visible light

Credit : Getty Images/EyeEm

- ANSWER -

Wavelength of visible light

Visible light is a narrow part of the electromagnetic spectrum that our eyes could detect. The visible light comes in different wavelength from the purple light at around 400 nm to red light at around 700 nm.



40 mm.
(Ping Pong Ball)

Previous
Rhinovirus

2.0 mm.

Next
Human red blood cell

Gym Ball



Rhinovirus

●••

- ANSWER -

Rhinovirus

Rhinovirus is a small virus responsible for common cold. Virus are made of protein shell that surrounds a genetic material. When we inhale a virus particle, it can hijack our internal cell system into replicating itself, developing into common cold.



40 mm.
(Ping Pong Ball)

Previous
Diameter of DNA helix

3.0 mm.

Next
Wavelength of visible light

Gym Ball



Diameter of DNA helix

●••

- ANSWER -

Diameter of DNA helix

DNA is the genetic material within our cells. DNA is made up from nucleic acid linking into a long spiral chain. The four nucleic acids made up for the “codes” that gives instructions to build every protein that made up of our bodies.



40 mm.
(Ping Pong Ball)

Previous
Water Molecule

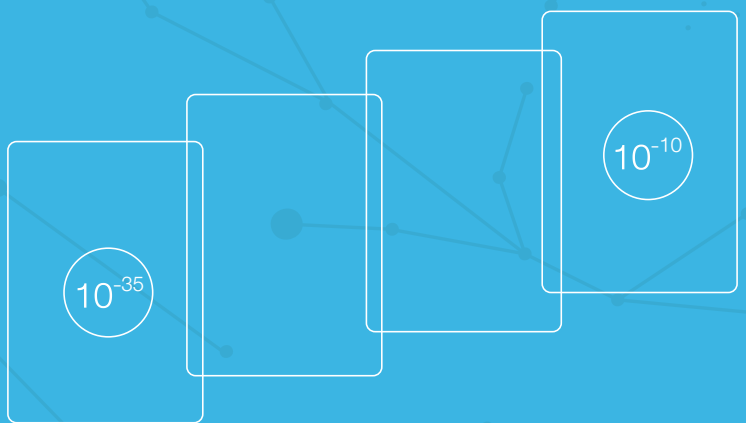
6.0 mm.

Next
Rhinovirus

Gym Ball

Molecular to Subatomic

Current physical theories provide us with a good understanding of fundamental particles, which are the building blocks of all matter around us. Physicists can study and test theories that explain particles too small for us to observe directly. Understanding these smallest particles, which make up the universe, will be key to gaining a deeper understanding of the universe itself.



Answer key explanation

- ANSWER -

Object **Princess Sirindhorn AstroPark**

Explanation It is the National Observatory of Thailand and the headquarters of the National Astronomical Research Institute. It is located in Don Kaew Subdistrict, Mae Rim District, Chiang Mai Province.

Circle represents the reference size.

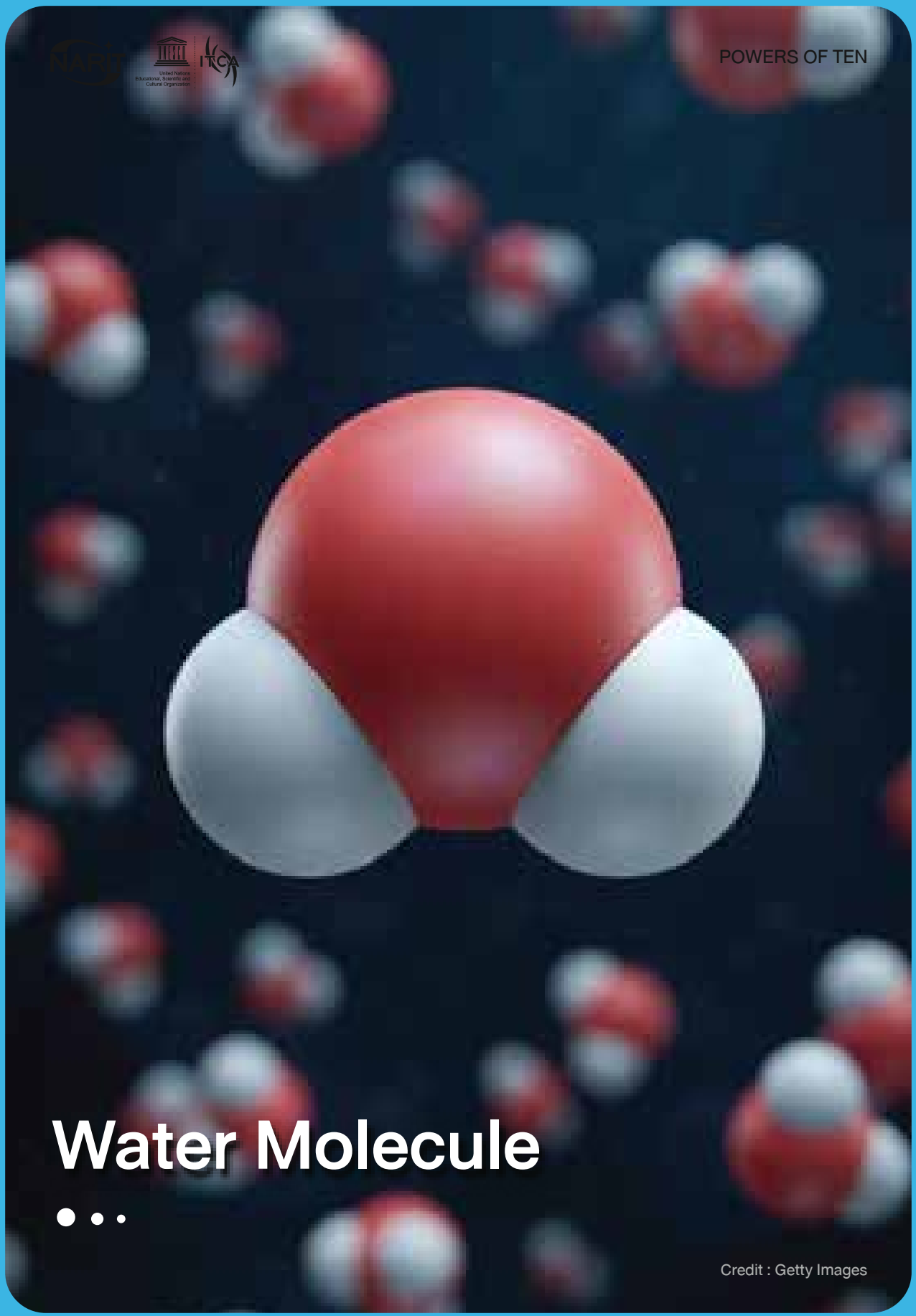
10^3

We are scaling down the object to the size of this circle.



Previous Size representation of the next smaller object in the sequence if the object is scaled to the reference circle.

Next Size representation of the next larger object in the sequence if the object is scaled to the reference circle.



Water Molecule

Credit : Getty Images

- ANSWER -

Water Molecule

Water is the single most important compound for all lives on Earth. On earth's surface, water assume a liquid form, but is actually made up from atoms of oxygens and hydrogens.



40 mm.
(Ping Pong Ball)

Previous
Helium Atom

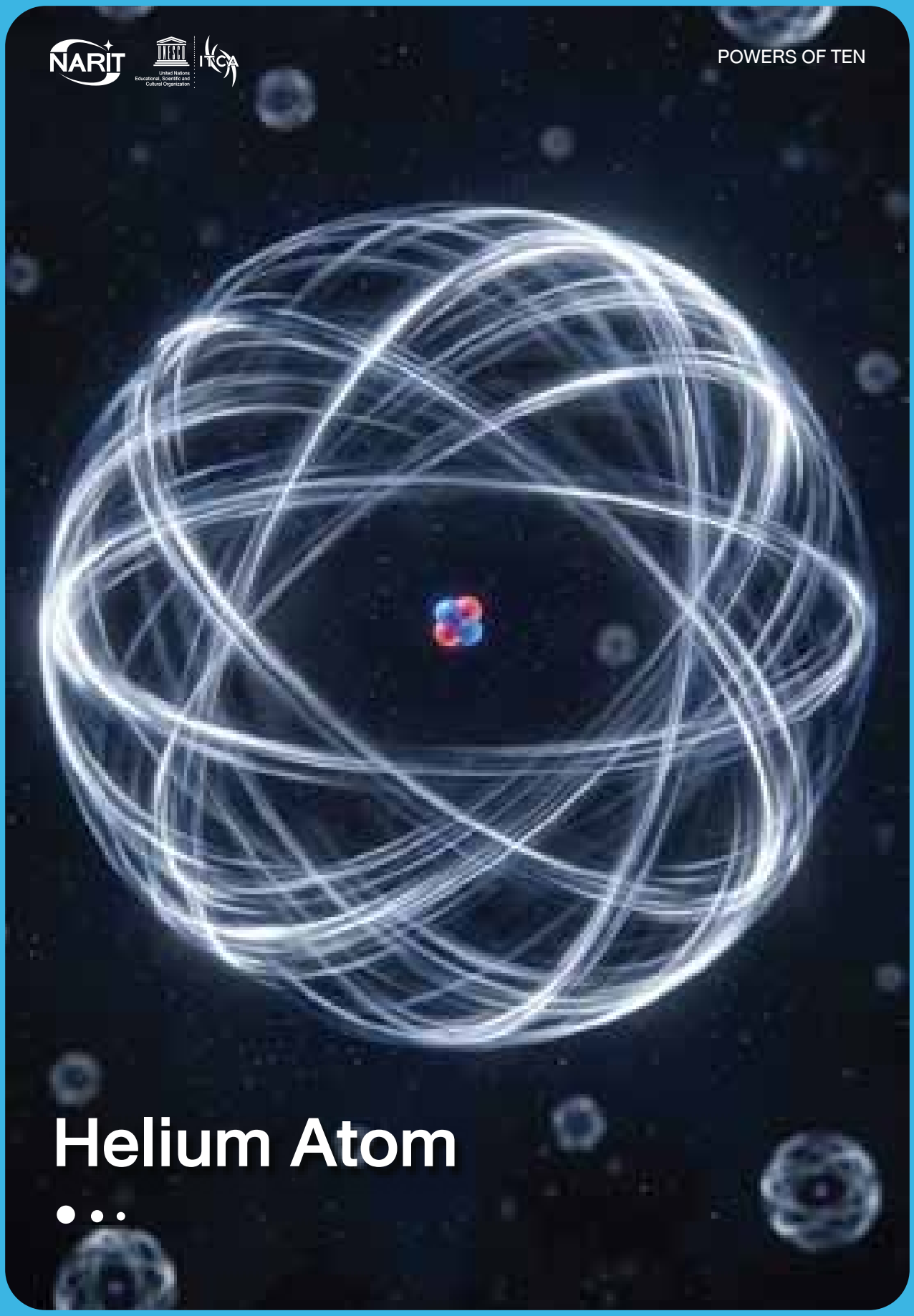


9.0 mm.

Next
Diameter of DNA helix



Soccer Ball



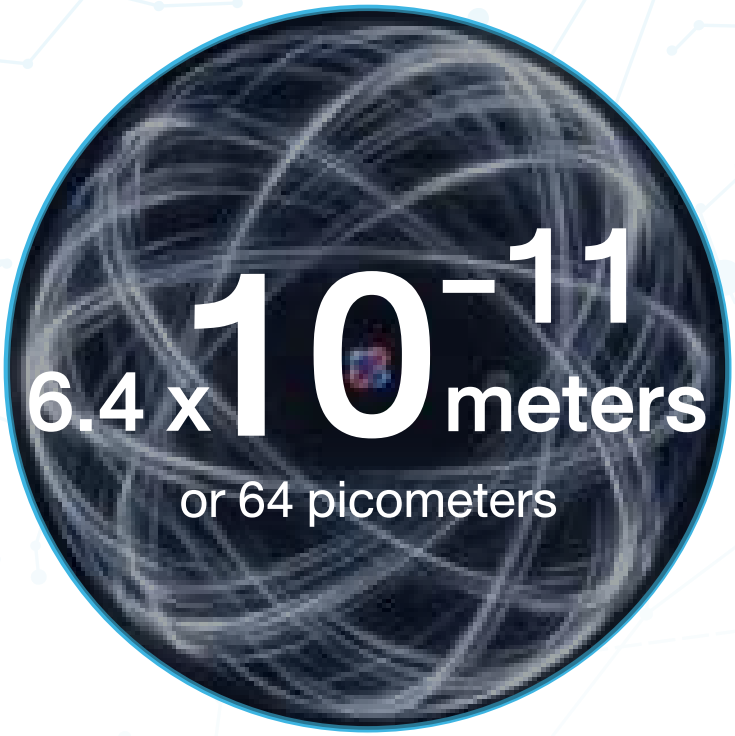
Helium Atom

●••

- ANSWER -

Helium Atom

Helium has the smallest atoms of all elements. On Earth, we might be most familiar with the helium in baloons due to its lighter than air properties. The Sun, however, generates over 596 million tons of helium every second as part of its thermonuclear reaction.



40 mm.
(Ping Pong Ball)

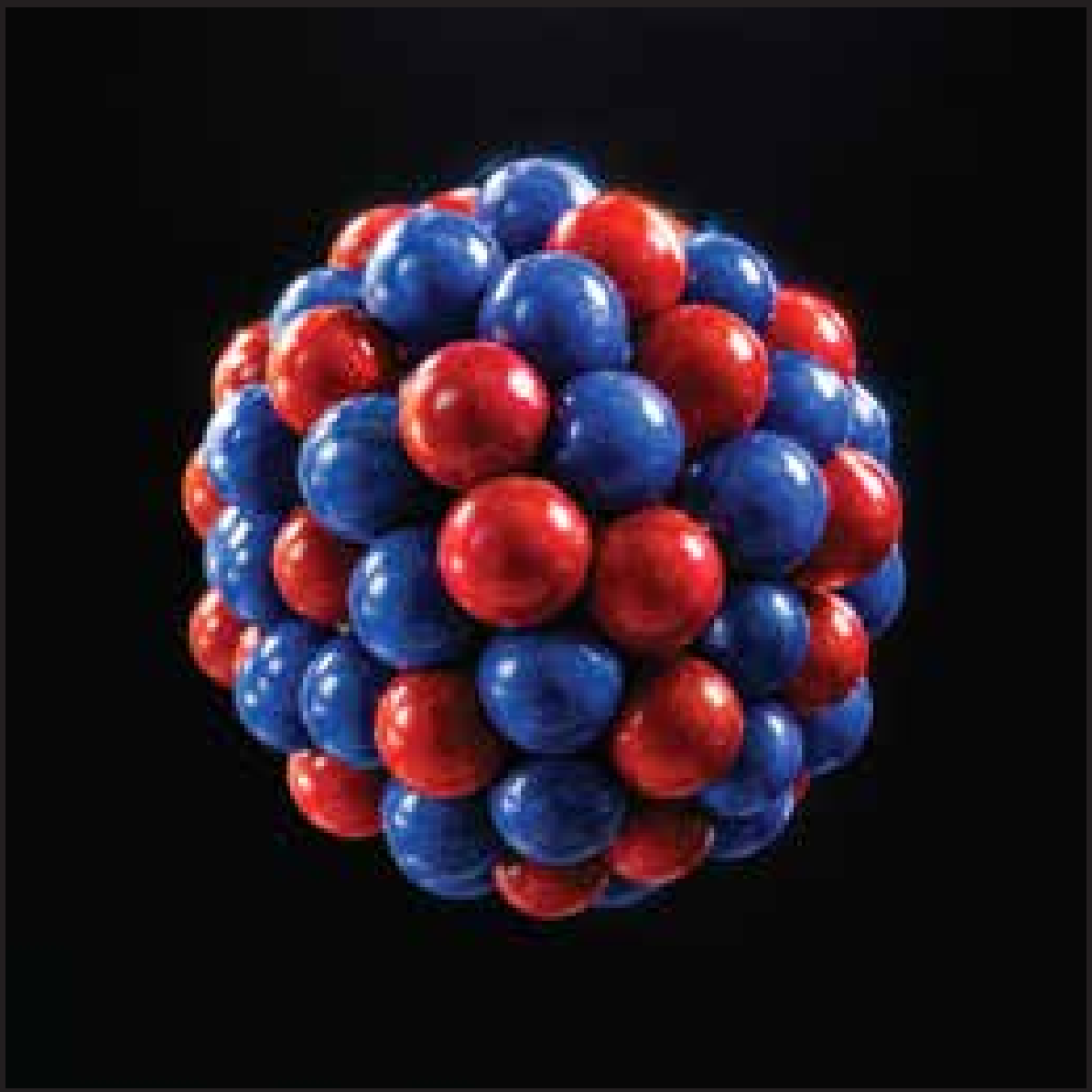
Previous
Nucleus of Uranium

Next
Water Molecule

0.01 mm.



Soccer Ball



Nucleus of Uranium

●••

- ANSWER -

Nucleus of Uranium

Uranium is a heavy element and has the largest nucleus ever found in nature. Nevertheless, nucleus is still extremely small compared to the size of an atom. If the nucleus of uranium is that of this circle, then the size of uranium atom is comparable to an entire stadium. surrounding it.



40 mm.
(Ping Pong Ball)

Previous
Proton



4.0 mm.

Next
Helium Atom



Stadium

POWERS OF TEN

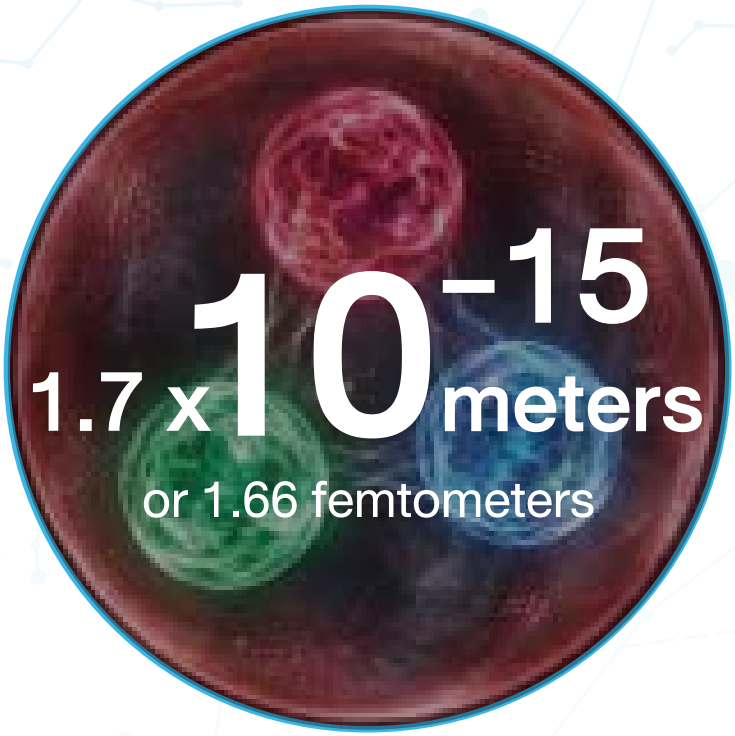


Proton

- ANSWER -

Proton

Protons are elementary particles within nucleus of everything surrounding us. Protons have positive charge and it is the number of protons in the nucleus that determines how an element behave.



40 mm.
(Ping Pong Ball)

Previous
Quark

0.002 mm.

Next
Nucleus of Uranium



Gym Ball

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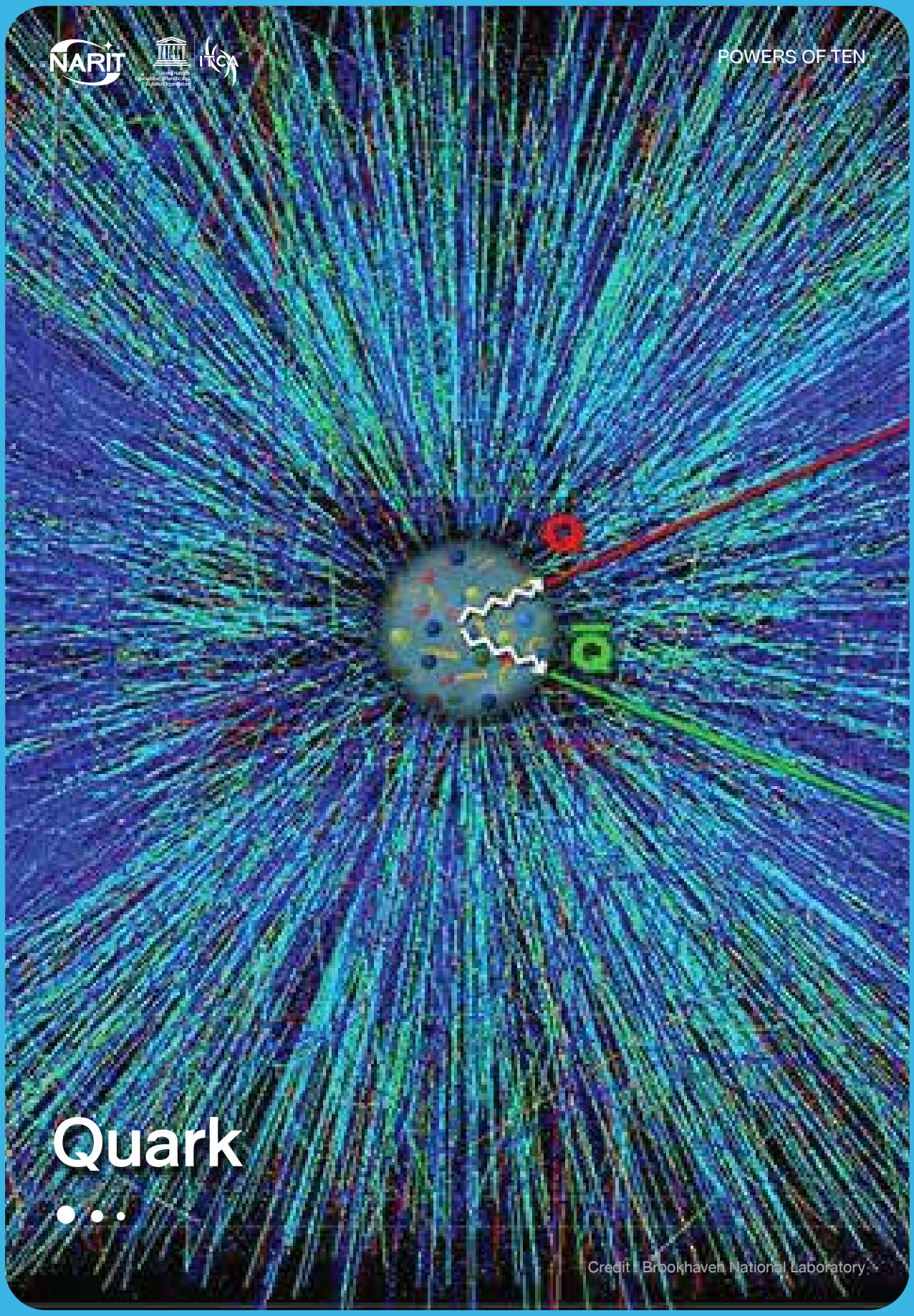
ITCA

POWERS OF TEN



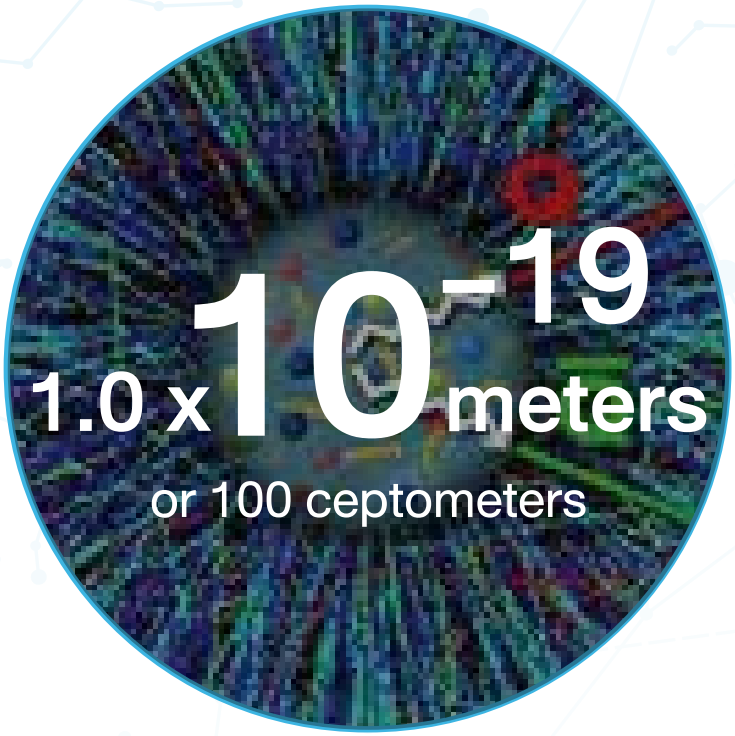
Quark

Credit : Brookhaven National Laboratory

- ANSWER -

Quark

Quarks is the most fundamental particles that made up of the matter that we know. Quark comes in different forms and each proton are made up from three quarks bound together.



40 mm.
(Ping Pong Ball)

← Previous
Neutrino

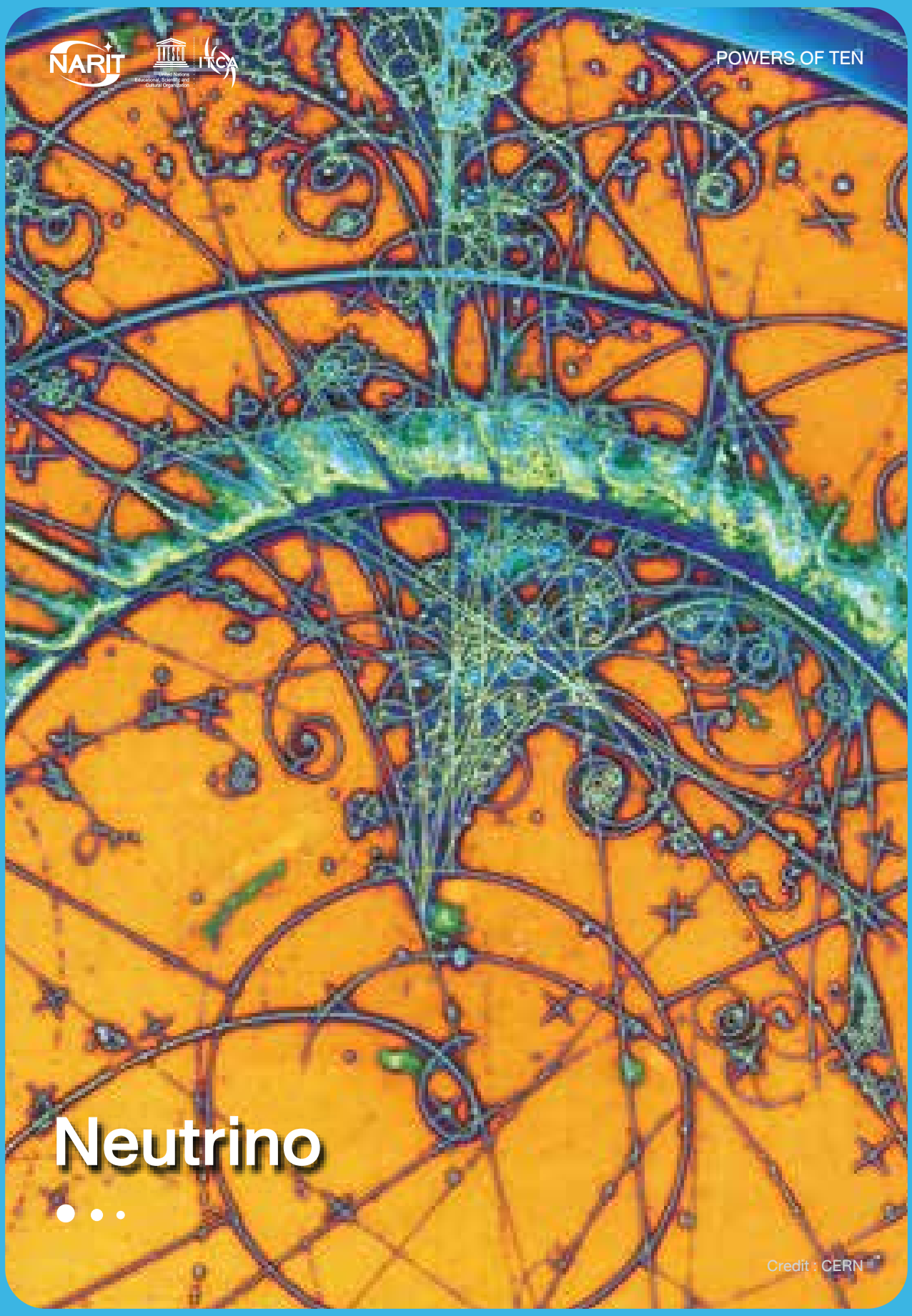


PM 2.5

Next →
Proton



Five Stadiums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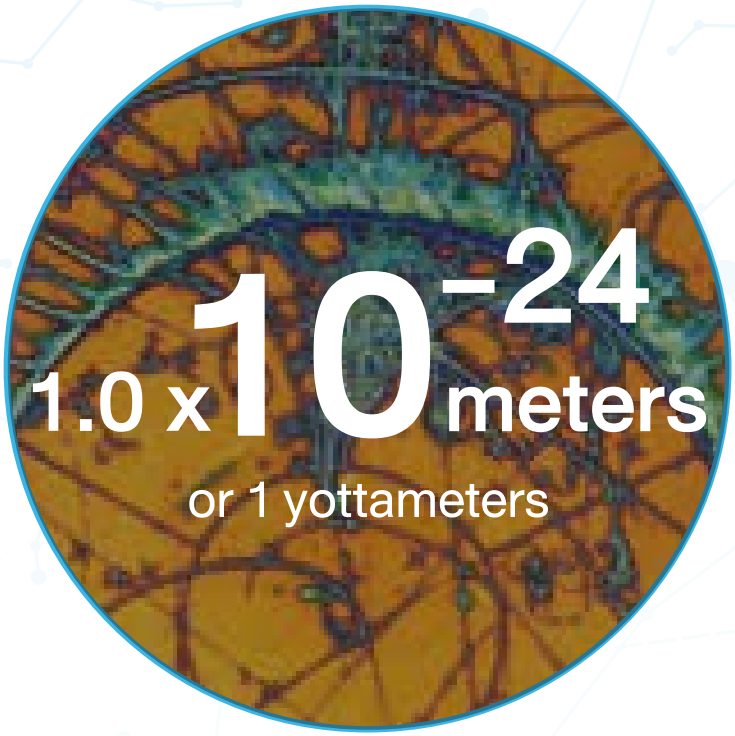
ITCA
POWERS OF TEN
Neutrino
Credit : CERN

- ANSWER -

Neutrino

Neutrino is the smallest particle in the universe. It has little to no mass at all and can travel near the speed of light. Every second there are over 100 trillion neutrinos passing through our bodies and entire earth beneath us before they escape through the other side of the Earth.



40 mm.
(Ping Pong Ball)

Previous
Planck's Length



atom-sized

Next
Quark



Mountain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ITCA
POWERS OF TEN
Planck's Length
• • •

- ANSWER -

Planck's Length

Confining the energy required to observe anything smaller than this size would collapse it to a black hole. This makes the Planck's length the current theoretical limit at which we could understand the universe we live in.



40 mm.
(Ping Pong Ball)

Next
Neutrino

The Sun