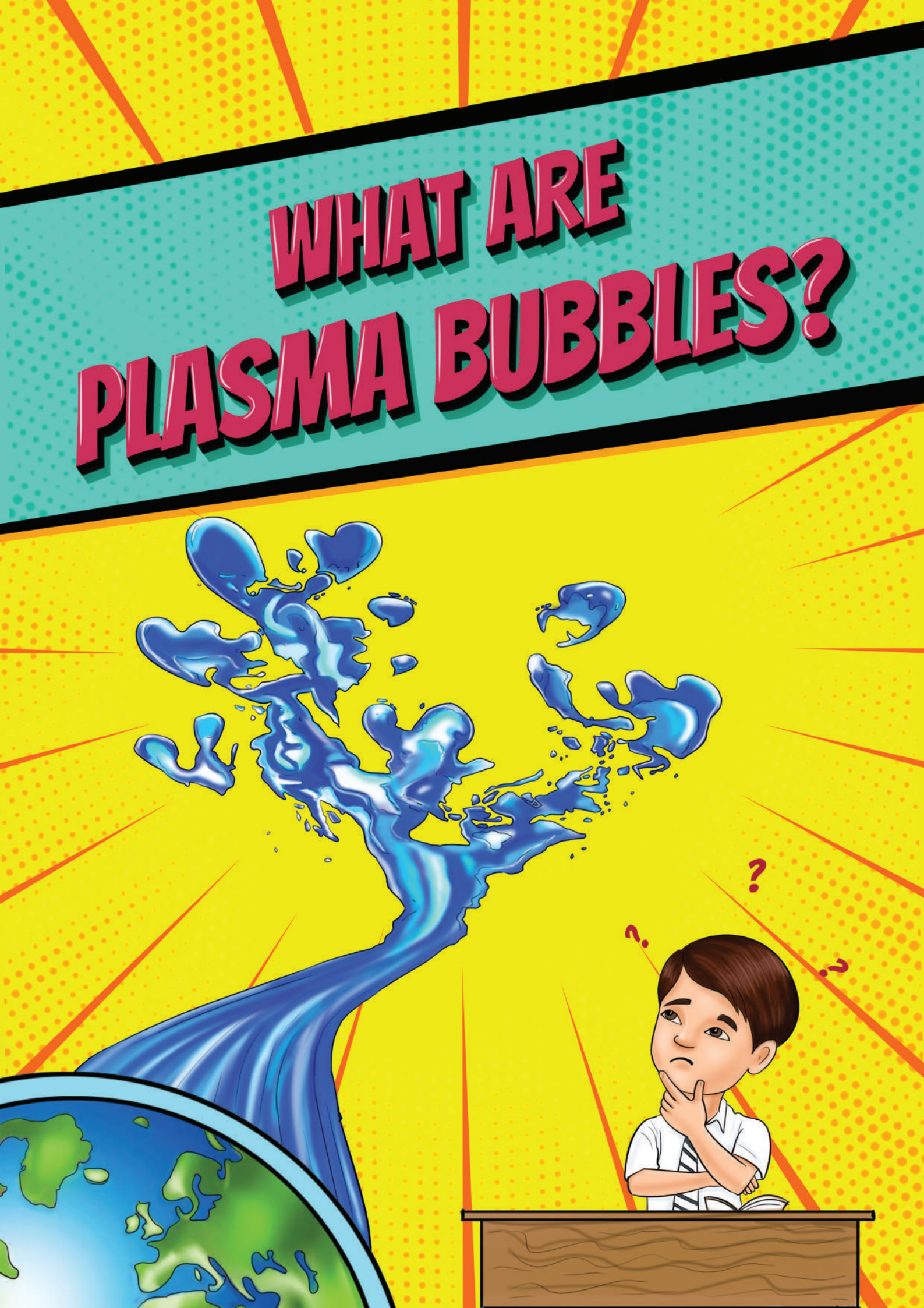
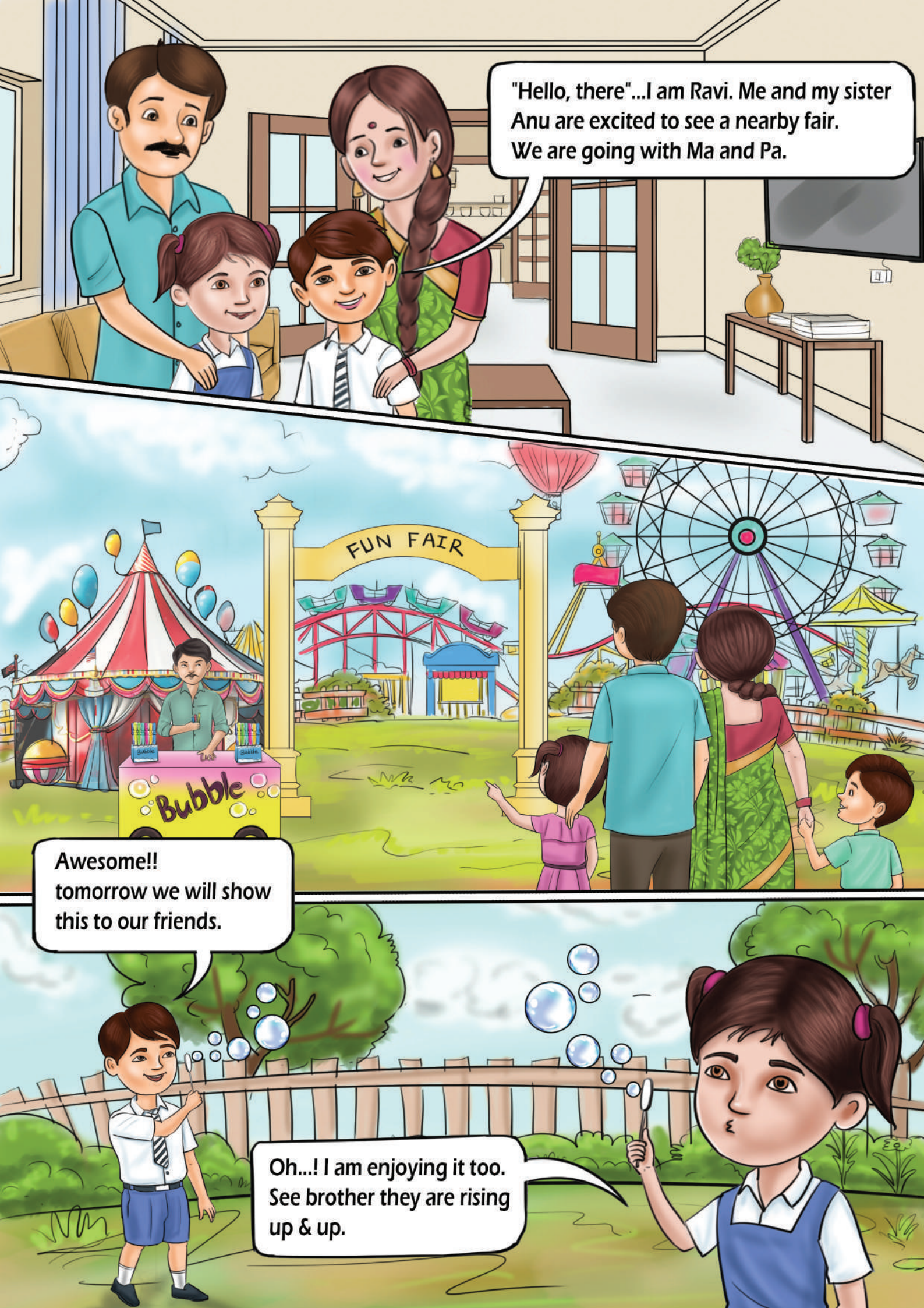
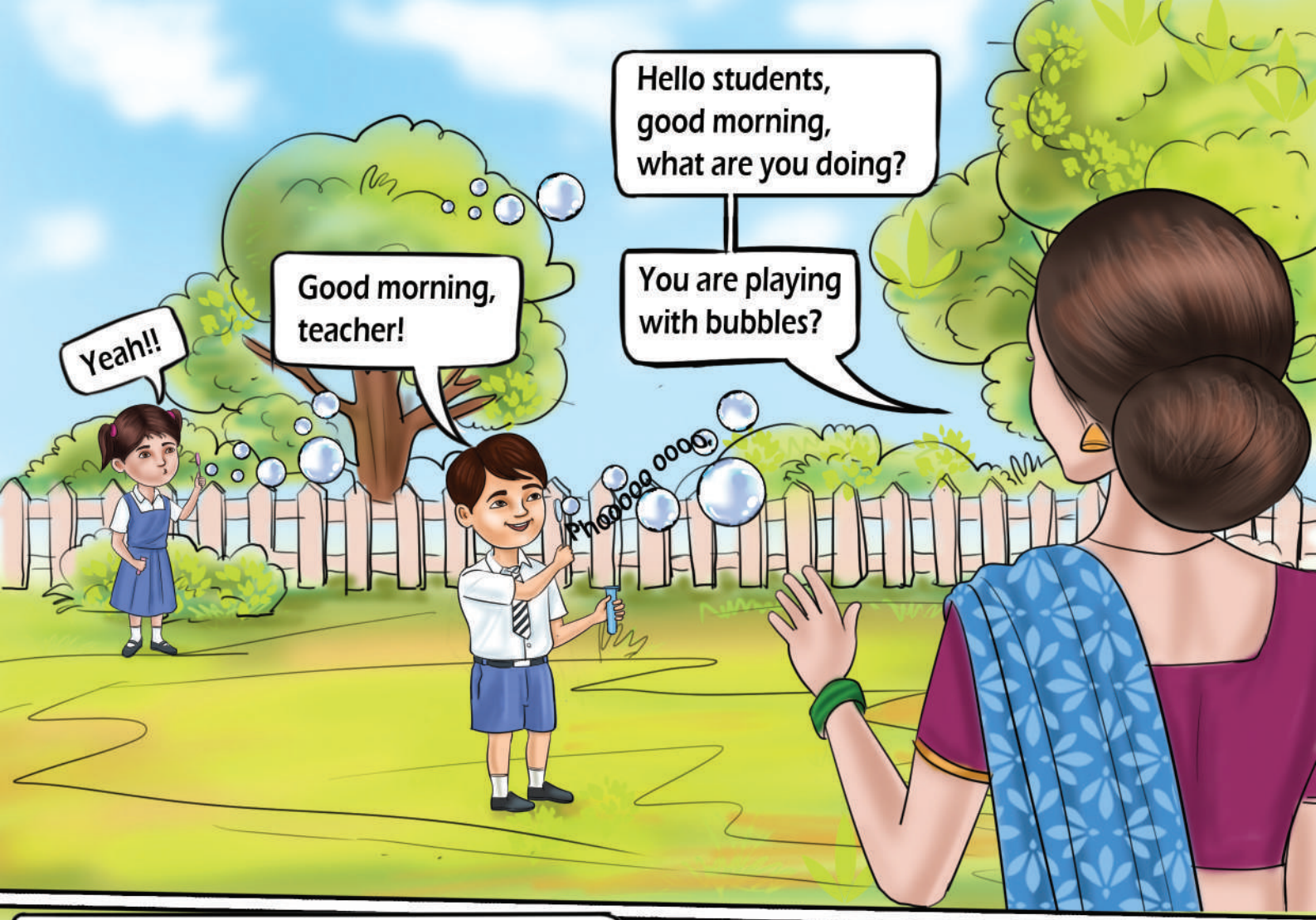
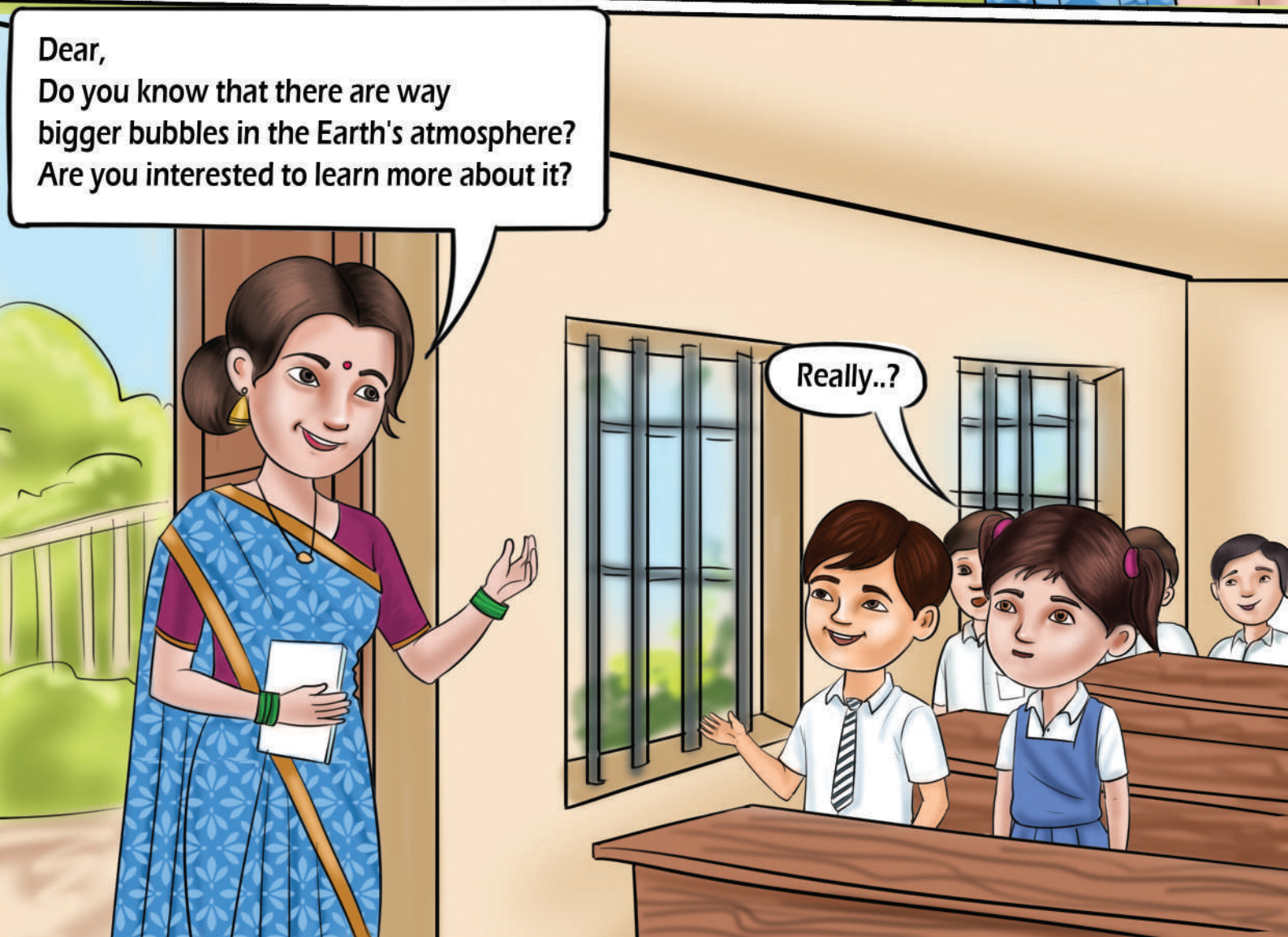
WHAT ARE PLASMA BUBBLES?




"Hello, there"...I am Ravi. Me and my sister Anu are excited to see a nearby fair. We are going with Ma and Pa.
FUN FAIR
Bubble
Awesome!! tomorrow we will show this to our friends.
Oh...! I am enjoying it too. See brother they are rising up & up.


NEXT DAY.....
Hi...Ravi..
Wow..Bubbles!!....
Can you show me?
SCHOOL
WOW!!
Where did you get it?
Oh...!
Let's play..
We got it from the fair yesterday.


Hello students,
good morning,
what are you doing?
You are playing
with bubbles?
Good morning,
teacher!
Yeah!!
Phoooooo oooo


Dear,
Do you know that there are way
bigger bubbles in the Earth's atmosphere?
Are you interested to learn more about it?
Really..?


Yes teacher,
we are interested.
Yes children,
it is called as Plasma bubbles.
Wow teacher!
Please tell us
more.
Can you tell us
more about this
big bubble ?

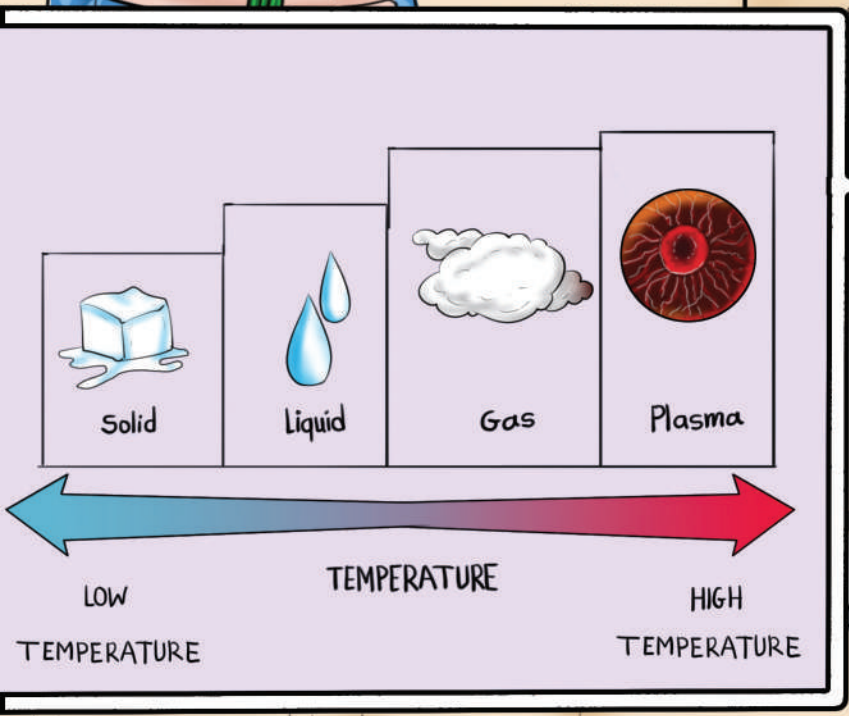

We never heard about it.
Plasma? What is that ?
Ok!!, First, let us understand what is plasma.
You know that there are three states of matter. Solid, liquid, and gases.
Yes teacher.

Actually, there are four states of matter, and among them one is Plasma state. It is fourth state of matter.

Fourth state of matter??

What is that ??

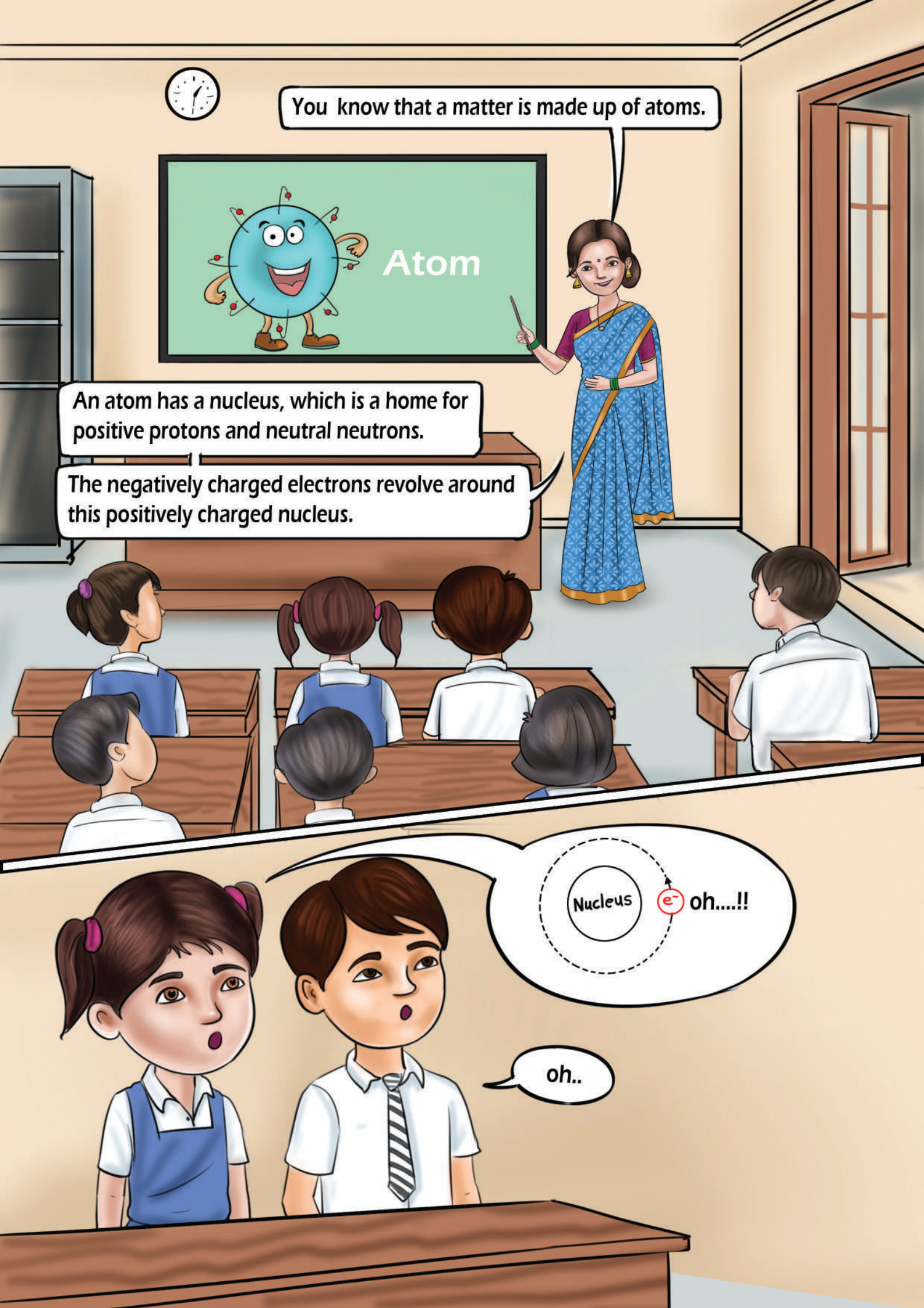
Fourth state?



Wait,
Ok, Let me answer your question one by one.

Plasma is an Ionised gas. When a solid is heated, it becomes liquid. After heating the liquid, it gets converted into gas. At very high temperatures, the gas is converted to Plasma.

What is the meaning of Ionised?

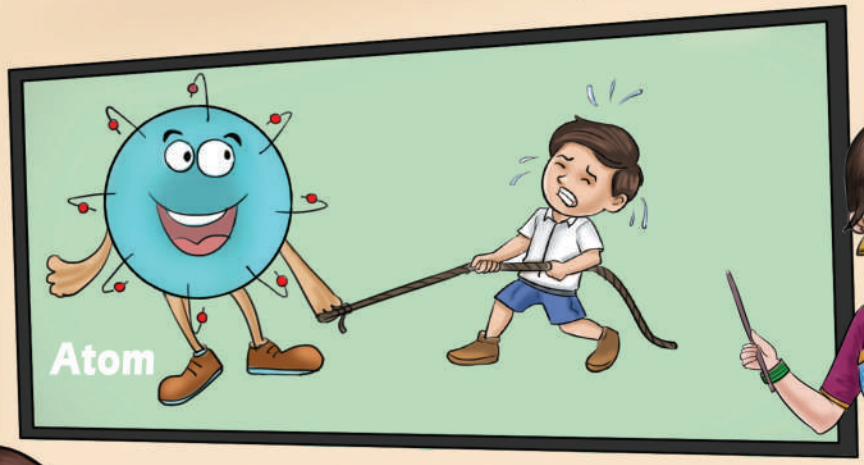

You know that a matter is made up of atoms.
Atom
An atom has a nucleus, which is a home for positive protons and neutral neutrons.
The negatively charged electrons revolve around this positively charged nucleus.
Nucleus
e⁻
oh....!!
oh..

If we give energy to these atoms, electrons may come out from the atom.

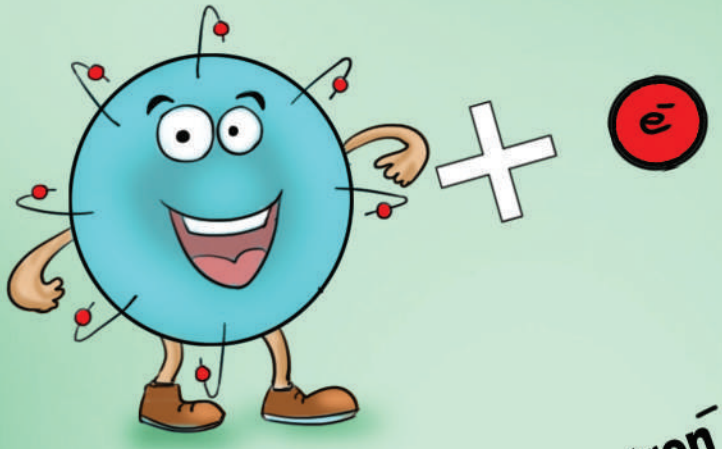
It results in the formation of positively charged ions and negatively charged electrons.

This process is called Ionization.

Quite interesting.

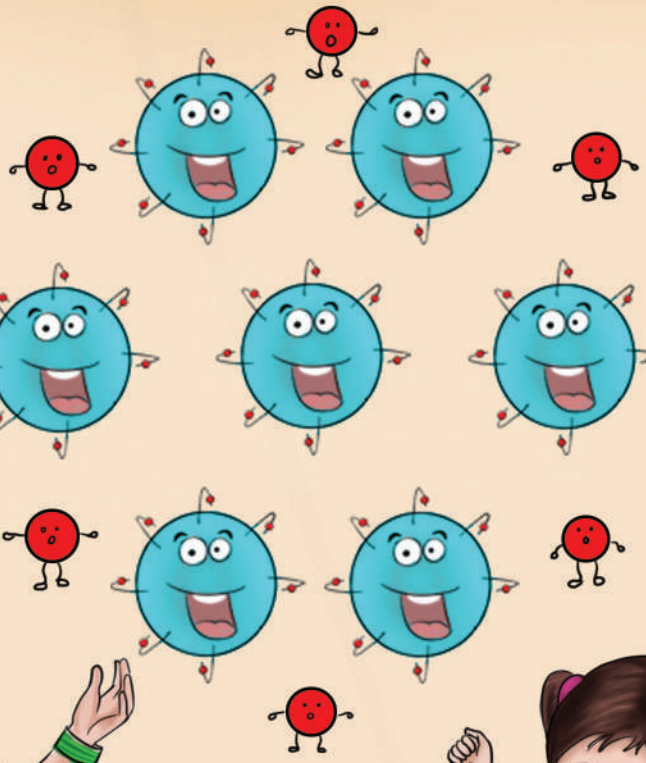


Oh, I see!!! Now I understood. It means we get positive ions and negative electrons from atoms by giving some energy.



Atom + Energy = Ion^{+} + Electron^{-}

The gas composed of such ions and electrons is called Plasma.



PLASMA

Yes, teacher.
We are excited to see Plasma.

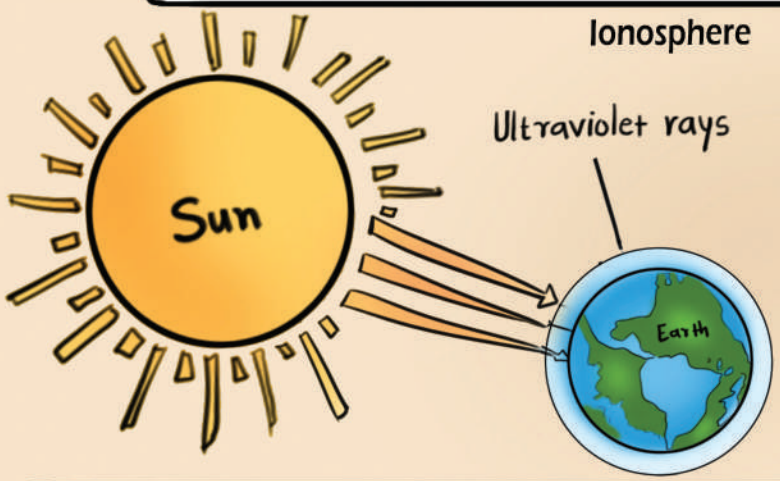
Where can we find Plasma?

It can be found in many places. Like the flash of a lightening bolt, fluorescent light tube, pixels of plasma TV, etc. and you know, we can also generate Plasma artificially in labs.

SUN

Our nearest star sun is a hot blob of Plasma. You know nearly 90% matter of our visible universe is in Plasma state.

You know, there are Plasma in Earth's atmosphere as well.

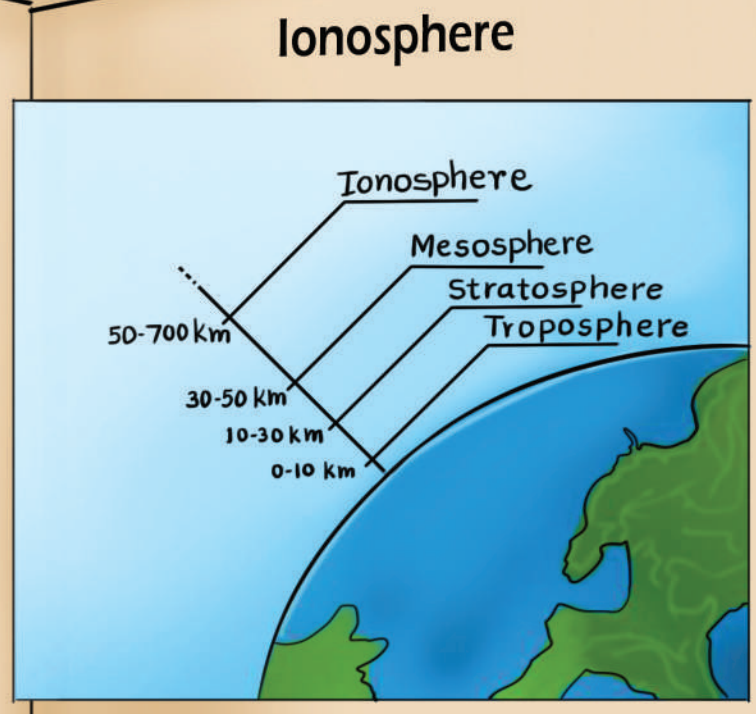


Sun's ultraviolet radiation ionizes the neutral atoms and molecules in the Earth's upper atmosphere, mainly oxygen(O2), nitrogen(N2), etc. forming a layer of Ionized species. It exists from 50 - 700 km above the surface of the Earth, and is called as Ionosphere. It has three regions: D,E and F.

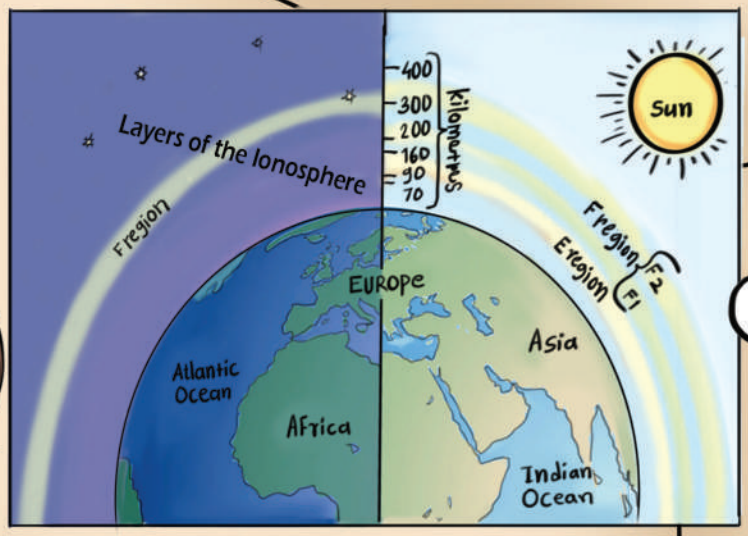
50 km!!

My uncle's home is about 50 km from here!

Very interesting!
So, it means..Ionosphere exists only during the day, due to the Sun light??



This is a very relevant question.



How teacher?

Ionosphere also exists during night.

Unlike Ionization, there is a process called Recombination,

where ions and electrons recombine to form neutral atoms or molecules but this recombination process is very slow in the F-region of Ionosphere.

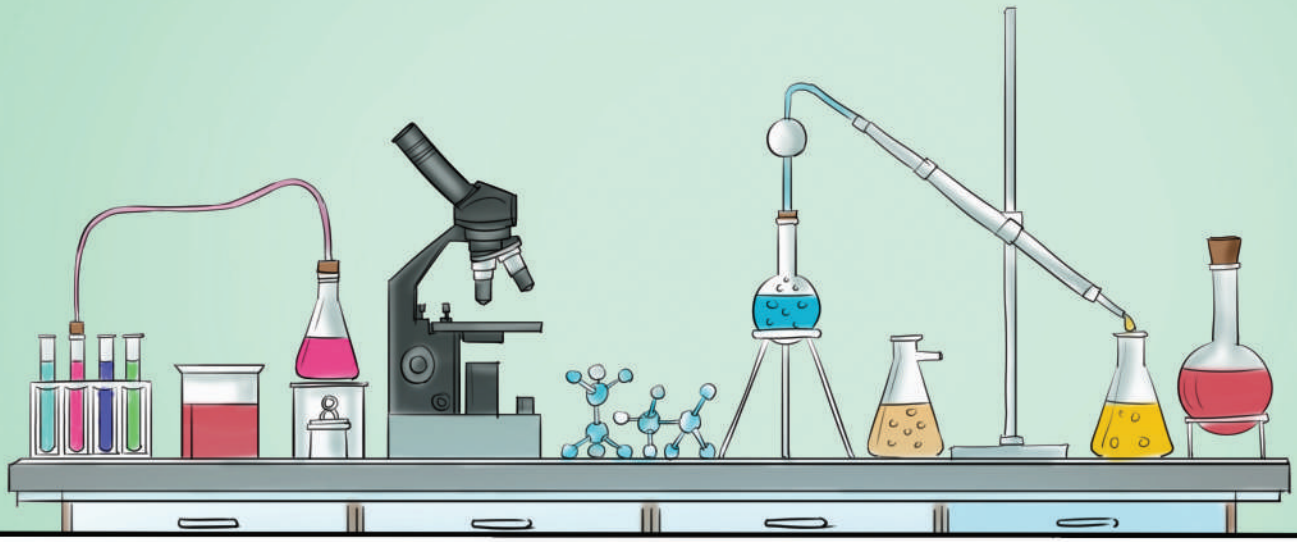
As recombination happens slowly, neutrals are also formed slowly.

And Ionization exist even during night in the F-region of the Ionosphere.

This is very interesting.....


What about the Plasma bubbles?
In this F-region, the Plasma bubbles are often formed after the sunset.
What's that!!
So, we have a situation like high density region (i.e. F-region) resting on the low density region (i.e. E-region).
We are confused teacher.
woah!!
What!!
How about a simple experiment?

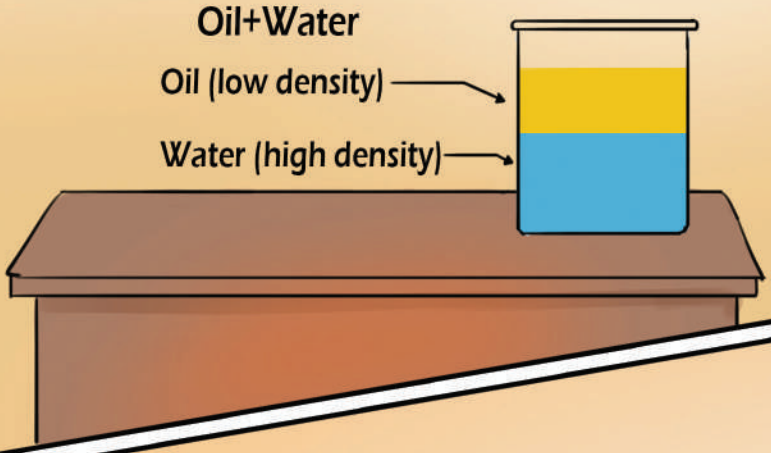
Lab



Ravi take water in a transparent glass. Then add oil to it.

As oil is lighter it will float on water. It is similar to a situation where low density fluid is resting on high density.

See, both liquids are very stable and remains unchanged.

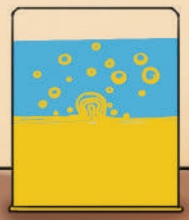


Yes teacher, I can see that.

Now close the glass with lid and flip the glass.

Now you have high density fluid (i.e. water) resting on low density fluid (i.e. oil), just see it.

Oil+Water



Unstable situation against gravity

Oh....!

I see one bubble.

Oil bubbles are rising up through the water.

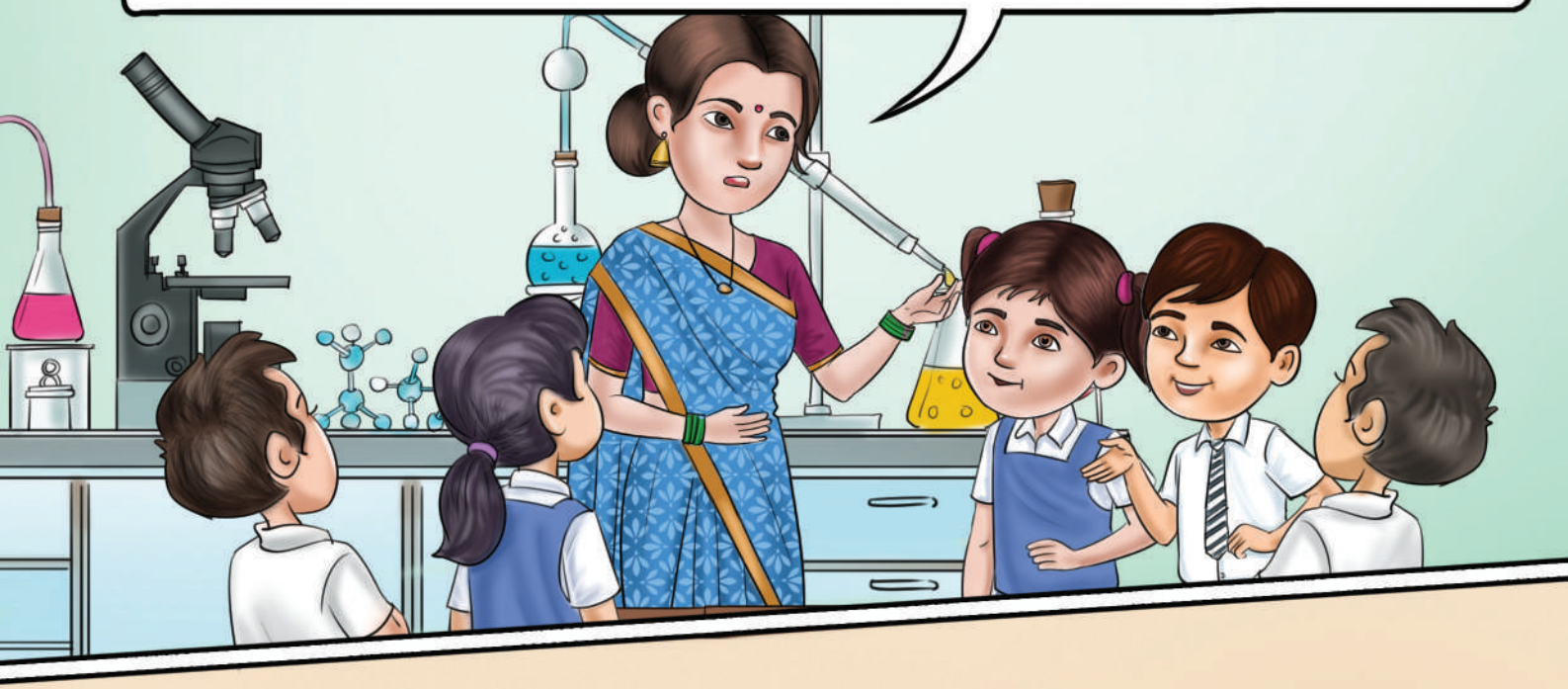
Teacher, the liquids are no longer stable.

Yes!!

More are forming.

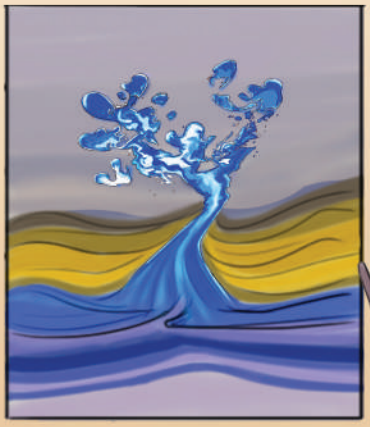
Exactly, this is an unstable situation, and oil bubbles are generated.

After Sunset F-region (high density) is resting on E-region (low density).
In such situation, bubbles are formed in Plasma, which are called as PLASMA BUBBLES.
It is mostly formed over the equatorial region of the Earth.



Difference between ordinary Balloon and Plasma bubble.

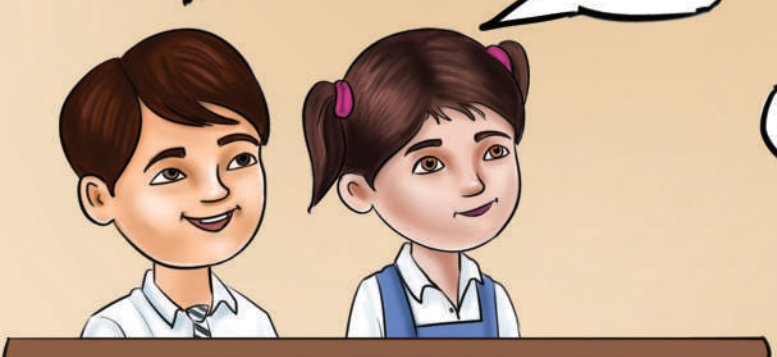
VS



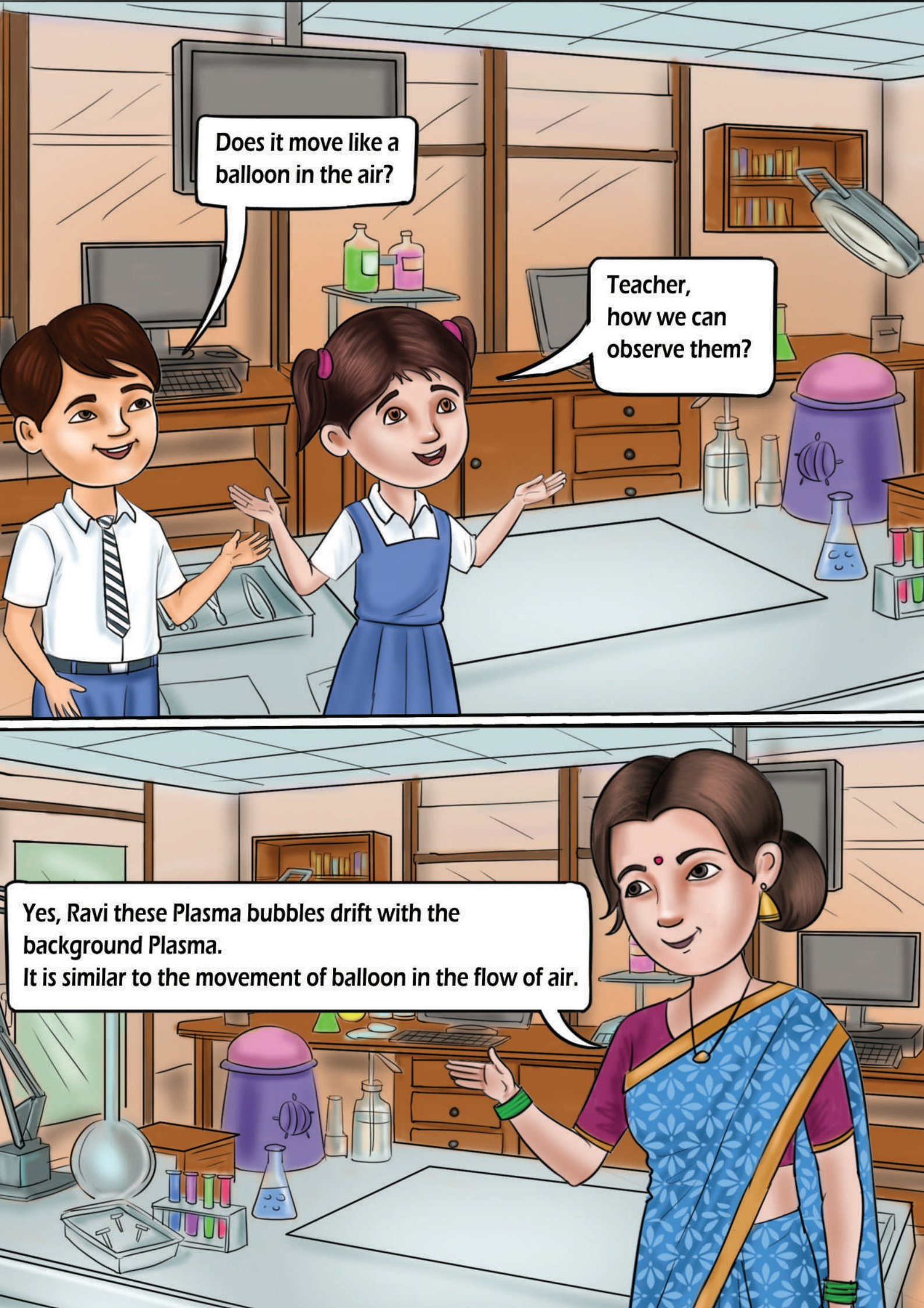
So, it is kind of a balloon?

Right!!

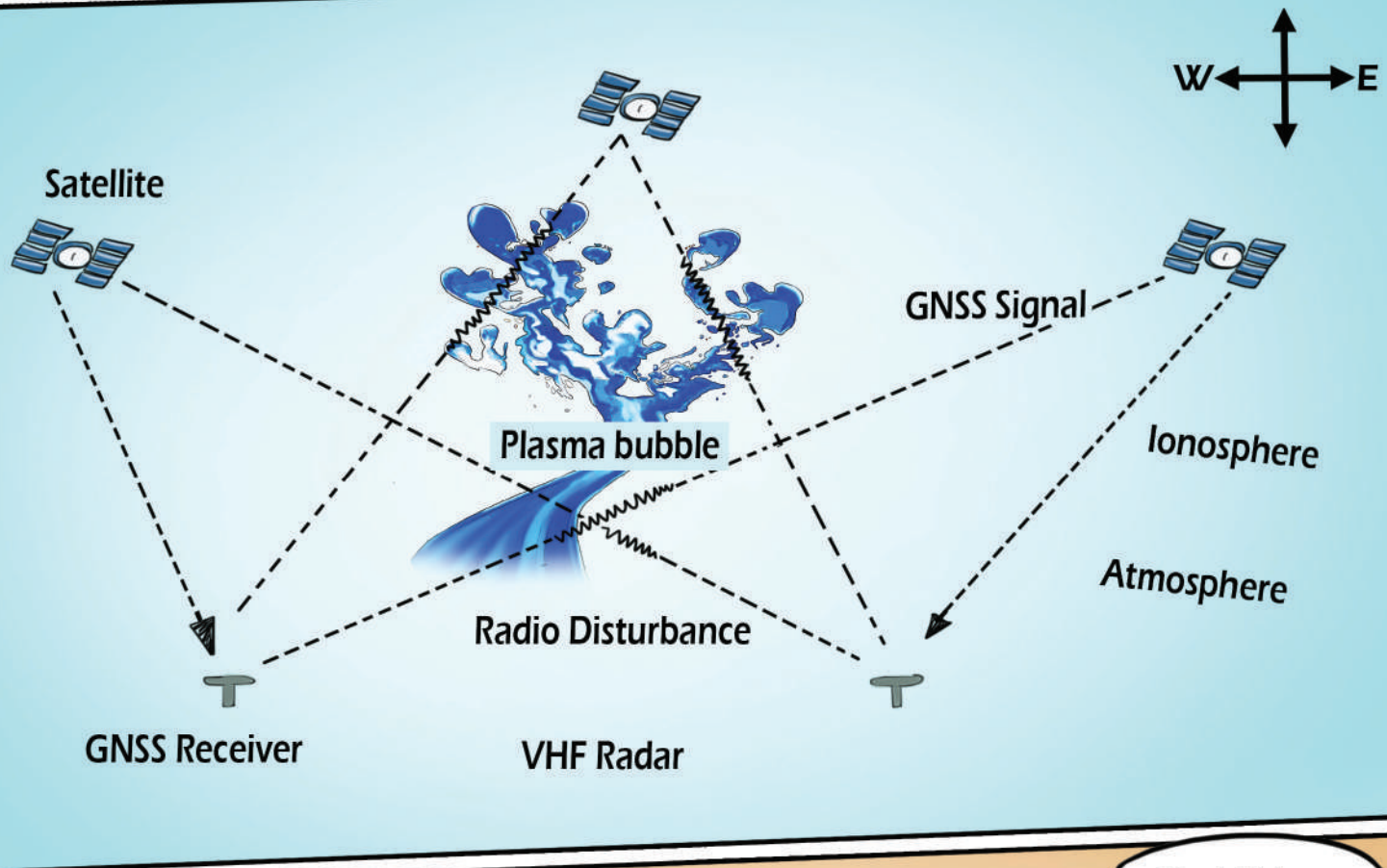
Let's compare!!



	Balloon	Plasma Bubble
Constituents	Rubber	Plasma
Interior	Lighter air inside	low Density Plasma inside
Shape	Smooth	It is irregular
Size	Small	Big (~ ten of kms)

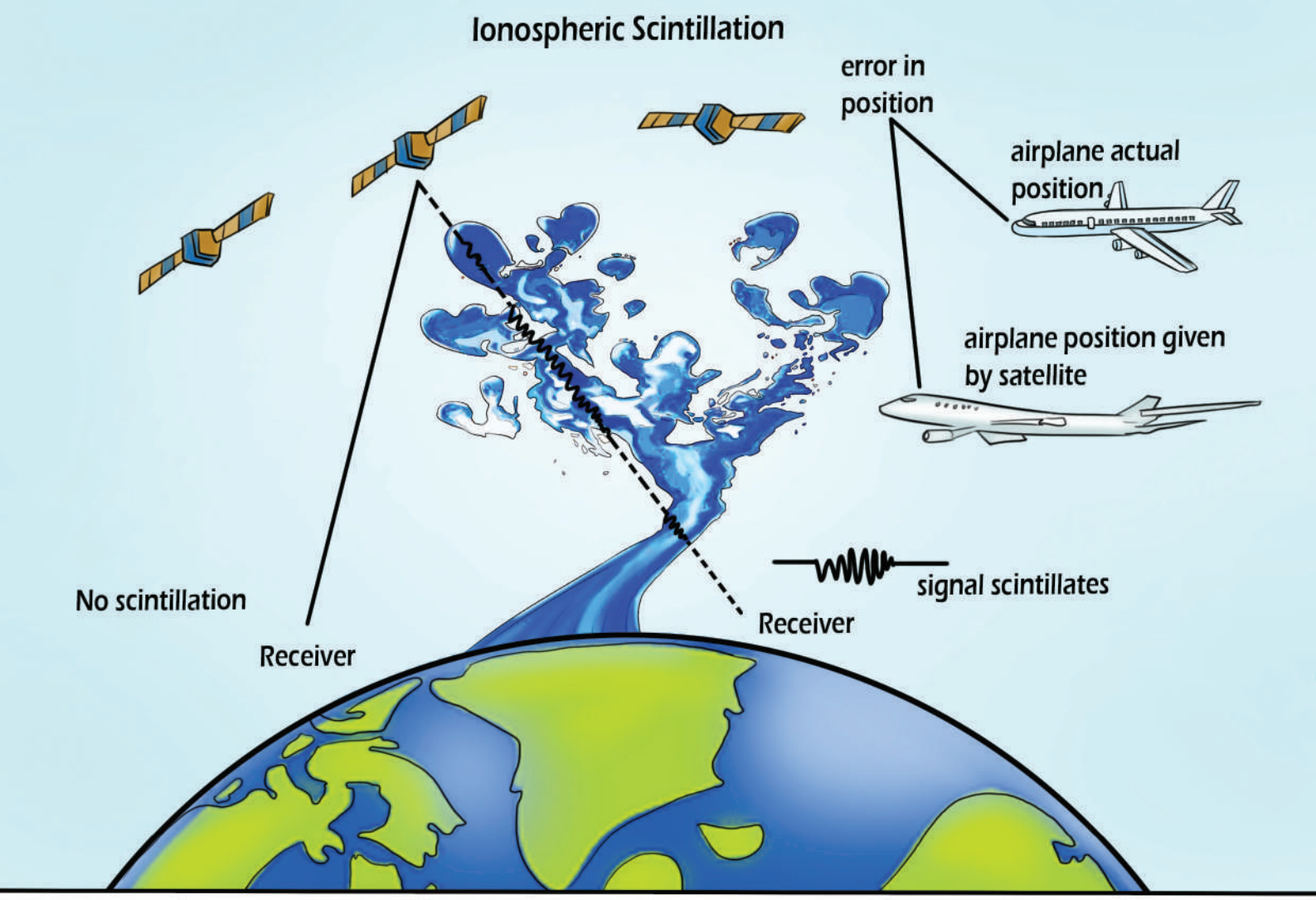

Does it move like a balloon in the air?
Teacher, how we can observe them?
Yes, Ravi these Plasma bubbles drift with the background Plasma.
It is similar to the movement of balloon in the flow of air.

It can be observed by many instruments like satellite, radar, and Ionosonde by measuring electron density.



Yeah! I know that too.

Yes, I got it. It is irregular Plasma. like irregular shape.



You know, these Plasma bubbles affects our navigation and communication radio signals.
When it passes through, it fades and scintillates.
Therefore, all over the world, scientists study their generation, evolution, characteristics and much more.

Thank you teacher, we learnt a lot about PLASMA BUBBLE.

Yes

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