



**I.P.R. Outreach Presents**



**"The Wonderful World of Plasma"**  
**Comic Series : I**

# STATES OF MATTER



Concept, Story &  
Script  
**Ravi A V Kumar**

Artwork &  
Layout  
**Ansh G Trivedi**



# STATES OF MATTER

## ***“The Wonderful World of Plasma” Comic Series #1***

This comic series is aimed at taking concepts of plasma physics to children and introduce them to the fascinating world of plasma and its applications.

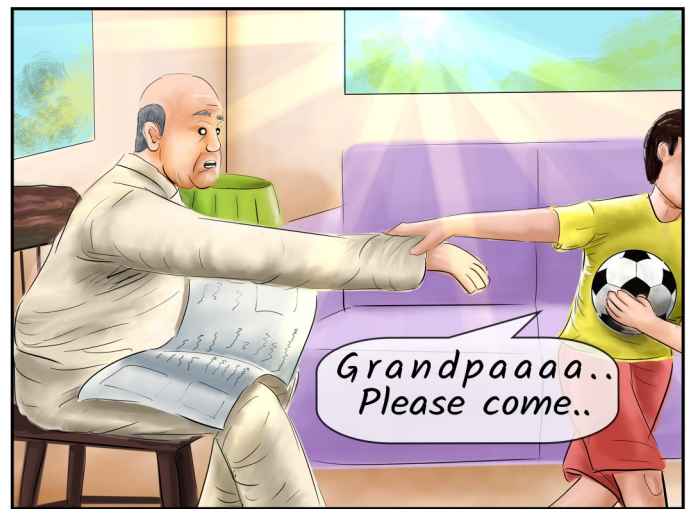
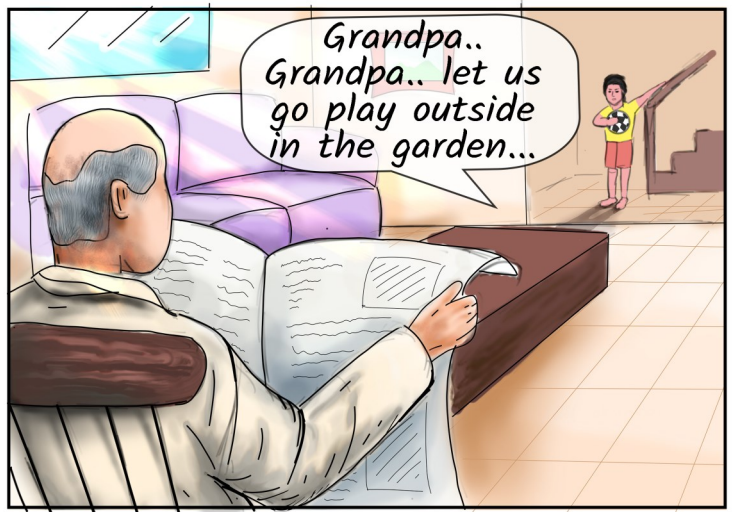
While the concept and script of this comic series was done in-house, the art and layout of the comic was done by **Ansh G Trivedi**, a talented, 12th standard student of Eklavya School, Ahmedabad.

We hope to bring out more issues of this comic series dealing with various aspects of plasma, its applications and energy from nuclear fusion.

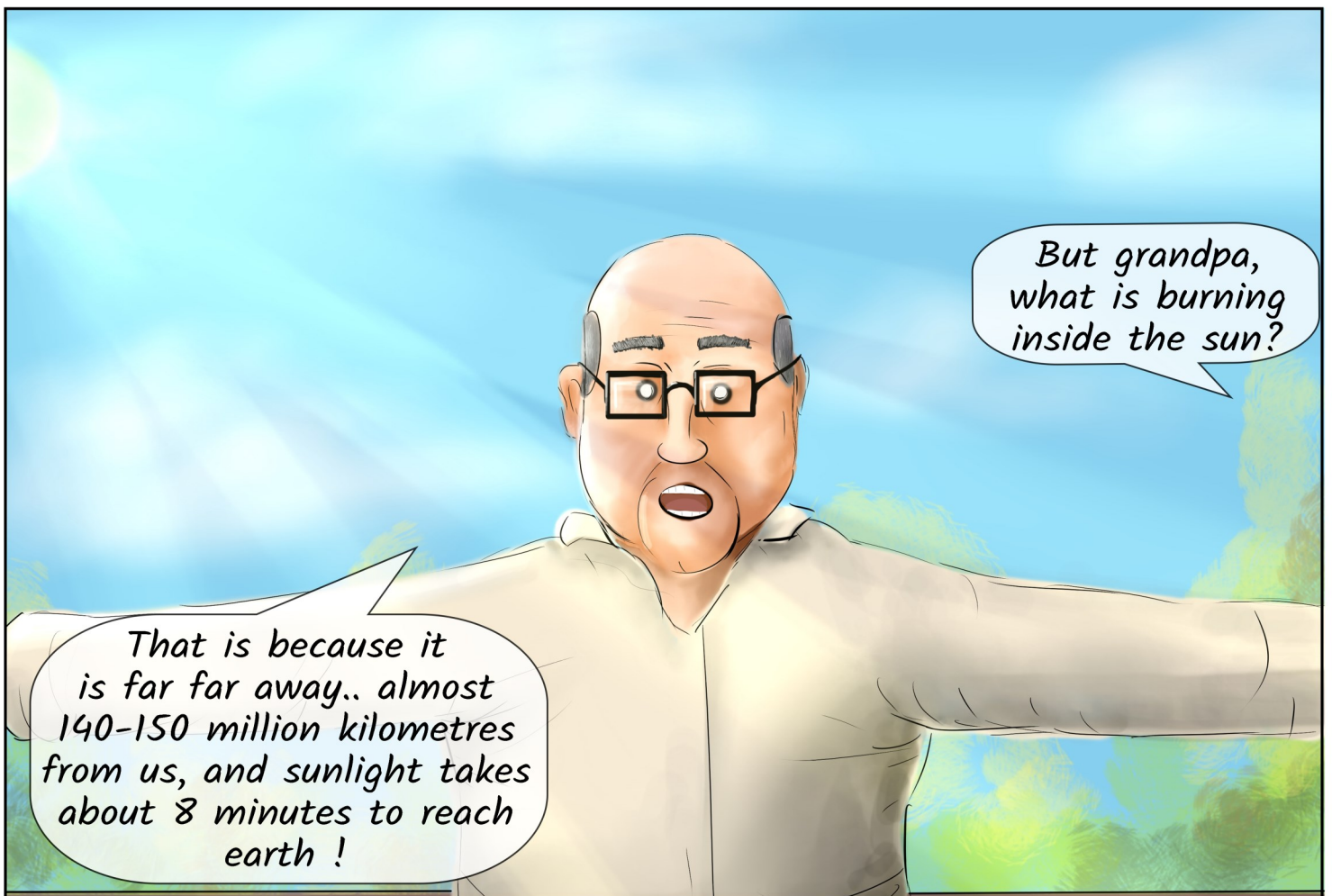
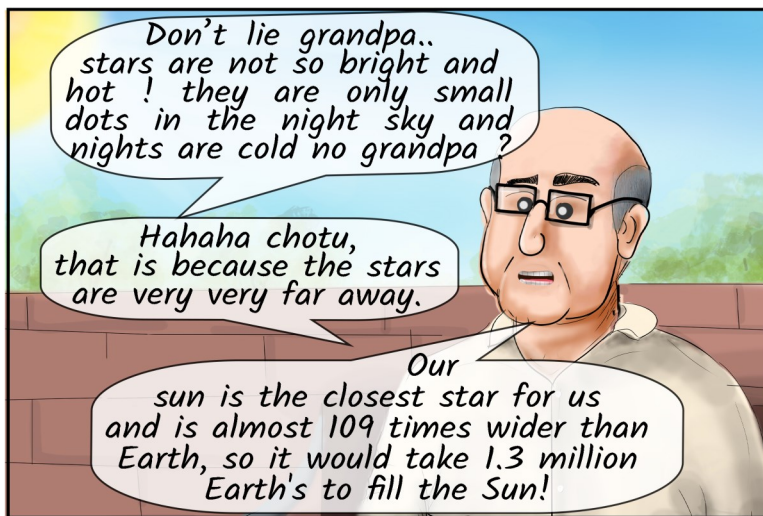
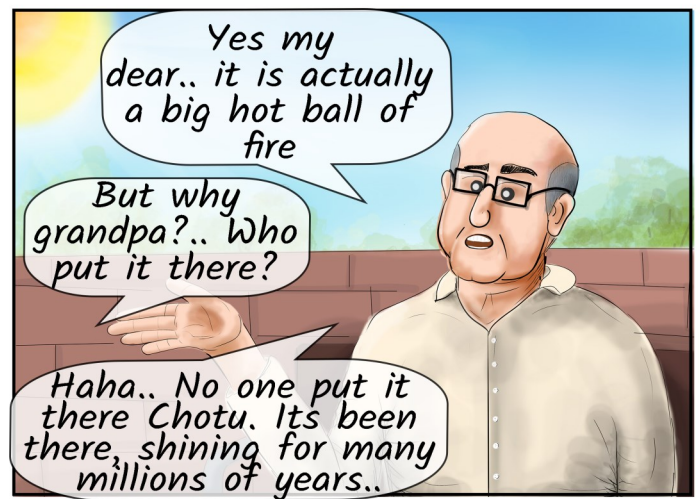
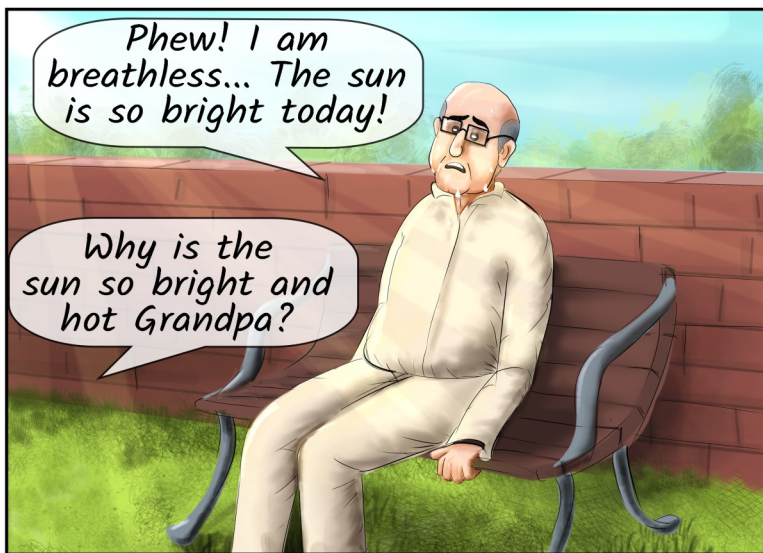
This scientific outreach activity is to commemorate 75 years of India's Independence.



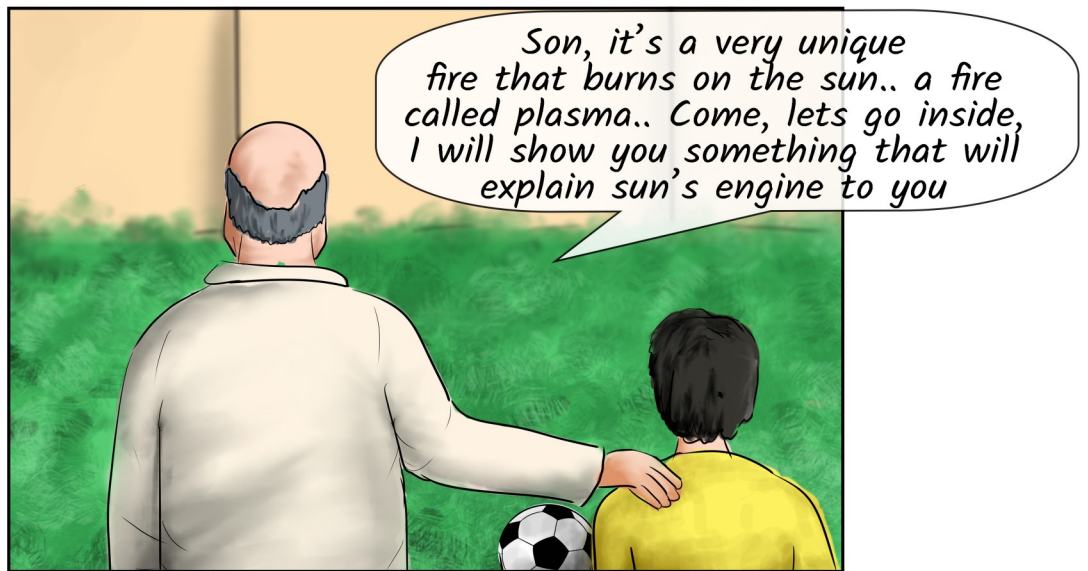




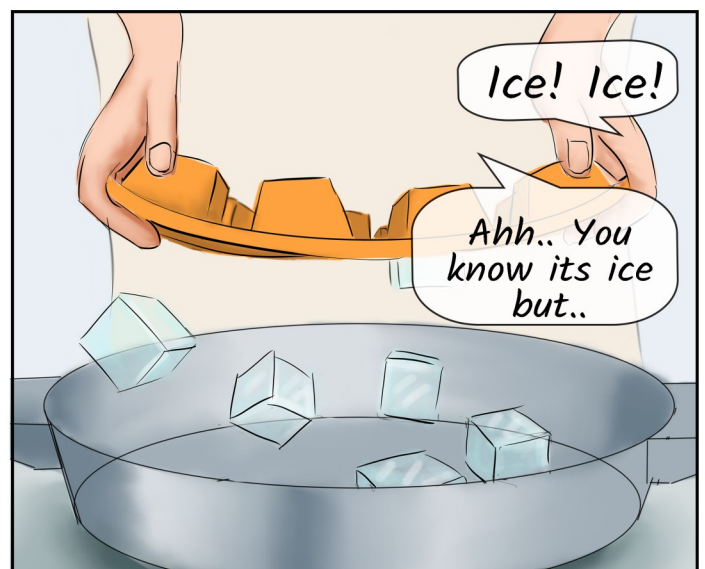
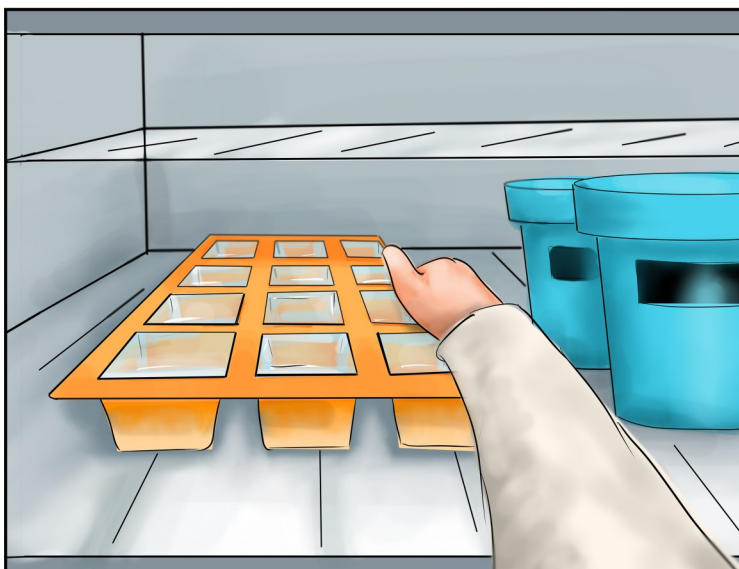
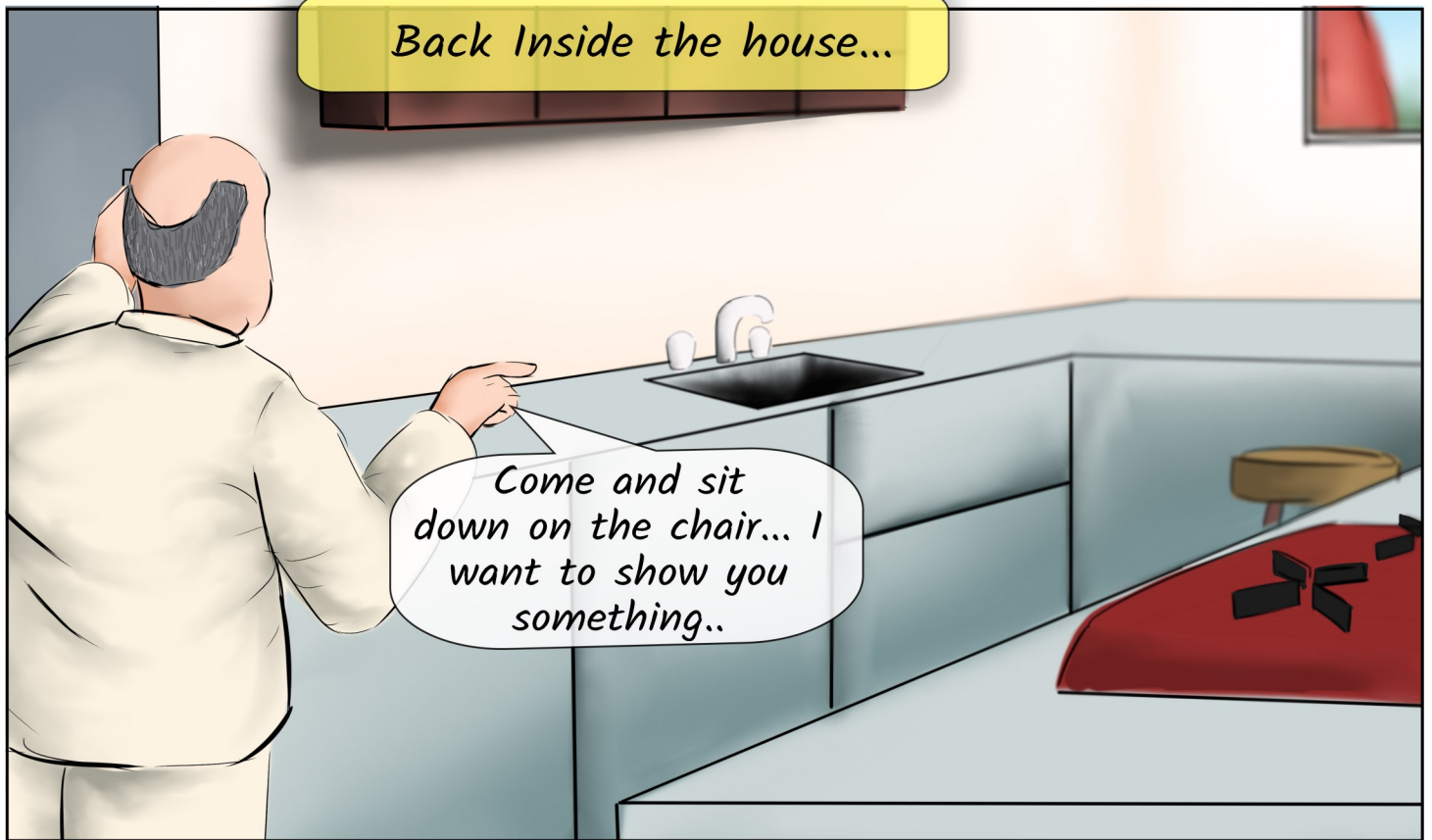




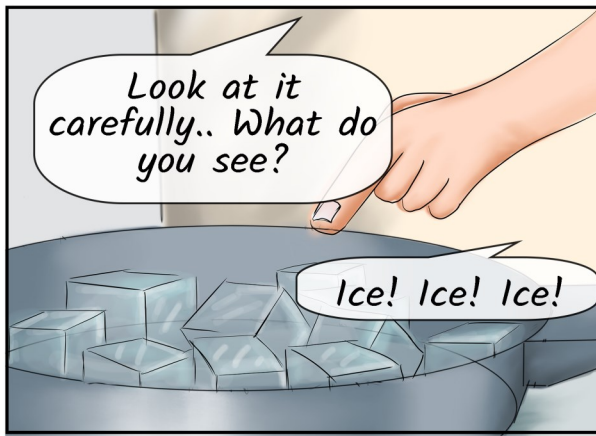




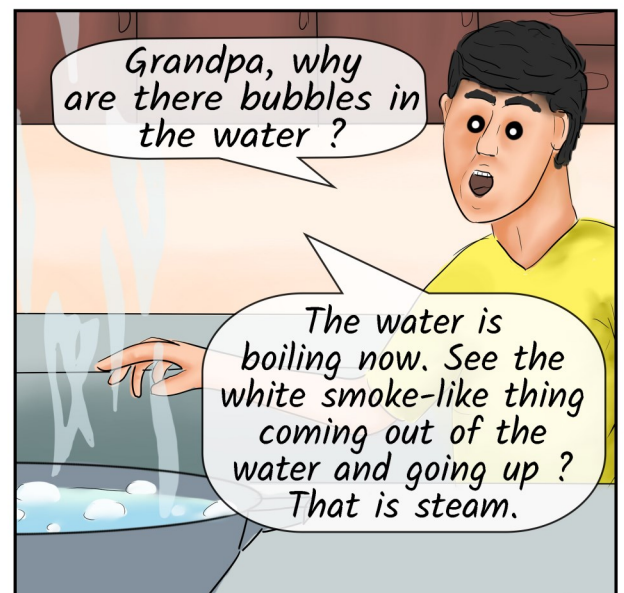
Back Inside the house...



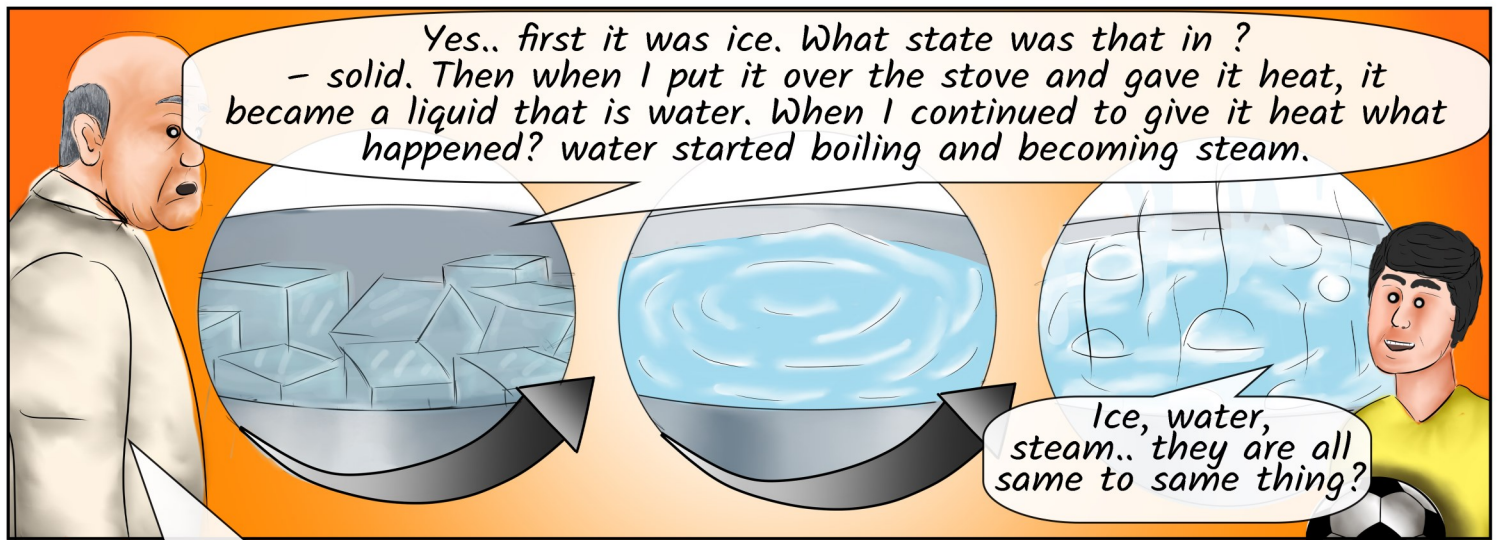




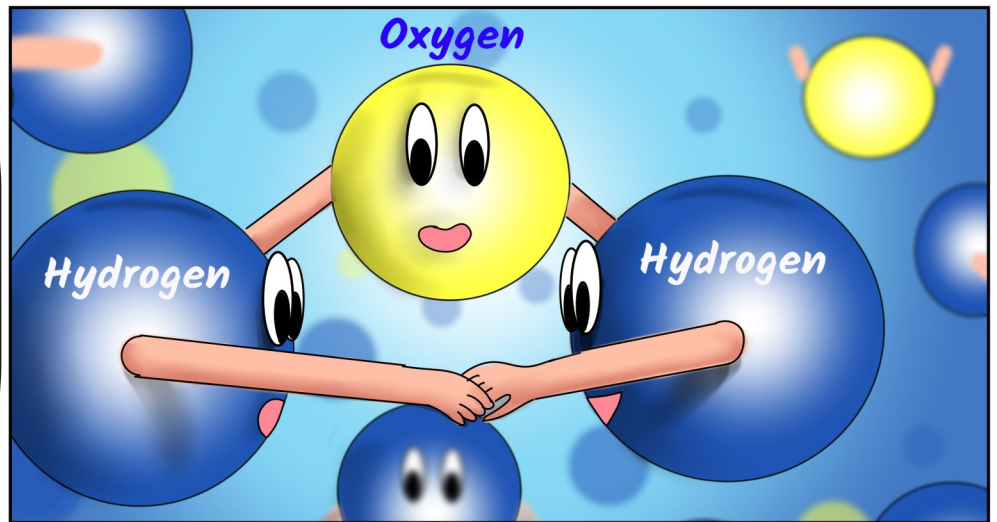
A few minutes later



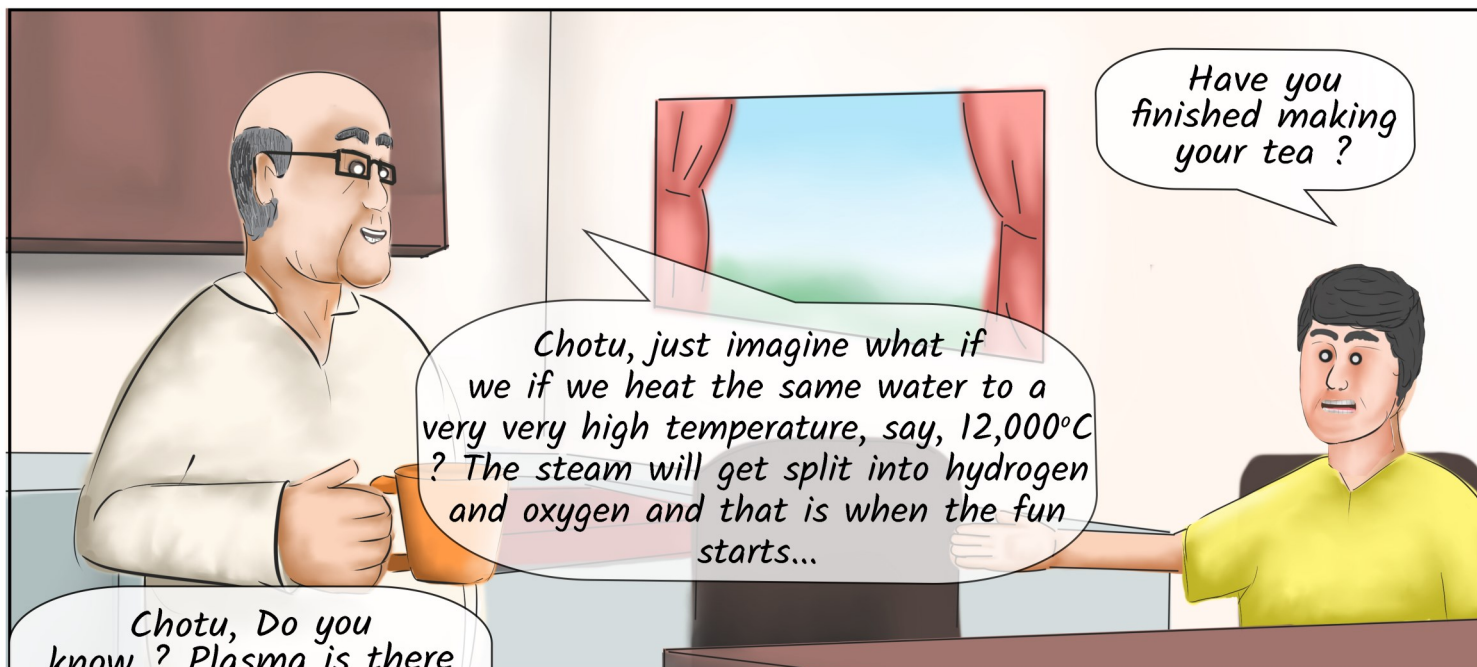




Yes. They are the same, two **hydrogen** and one **oxygen** atoms bound together, but in different states. Ice is **solid**, water is **liquid** and steam is **gas**. The three states of matter. By giving it energy (heat) we can take it from solid state to gaseous state.



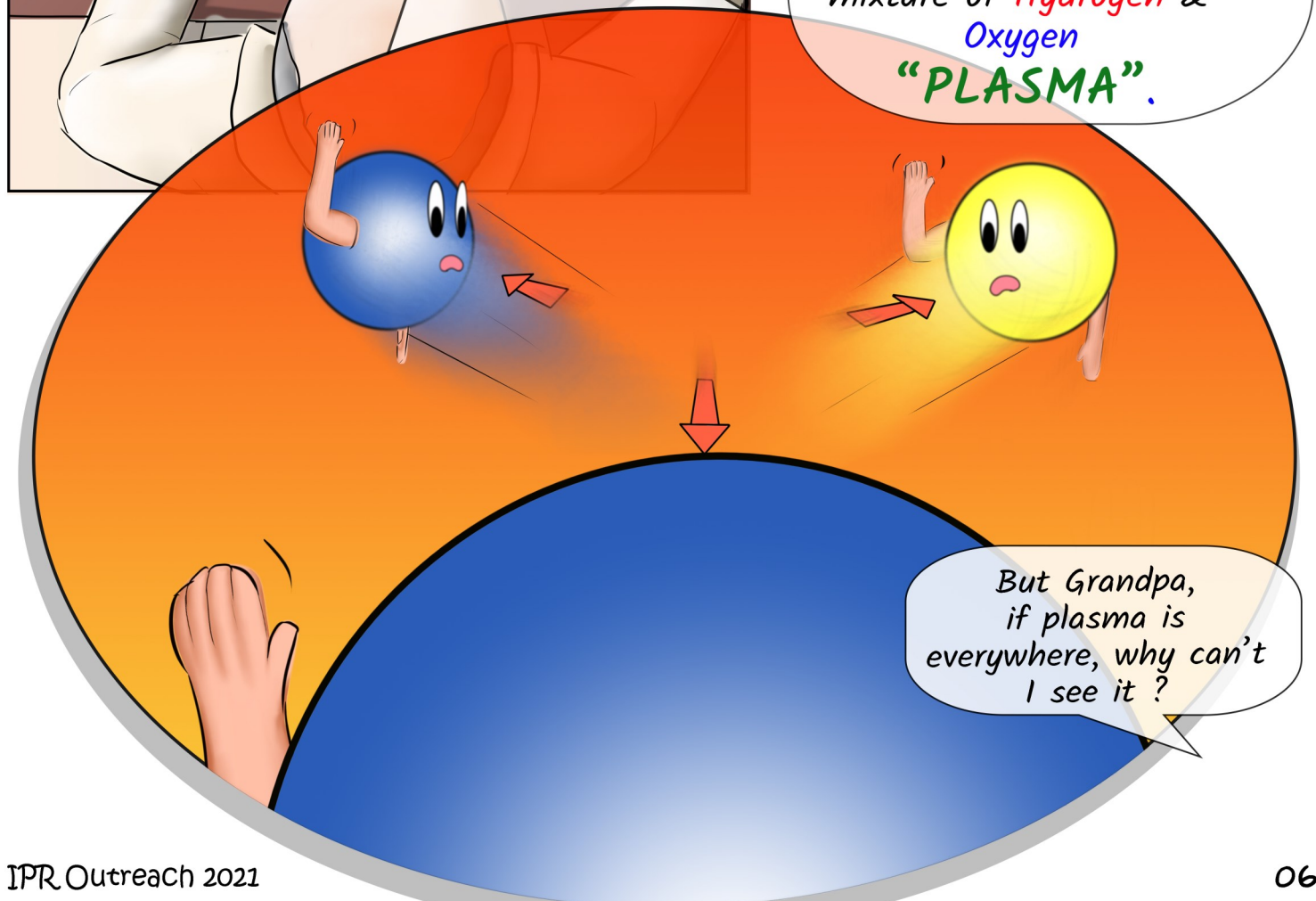




Chotu, Do you know ? Plasma is there everywhere and you don't even realize it !

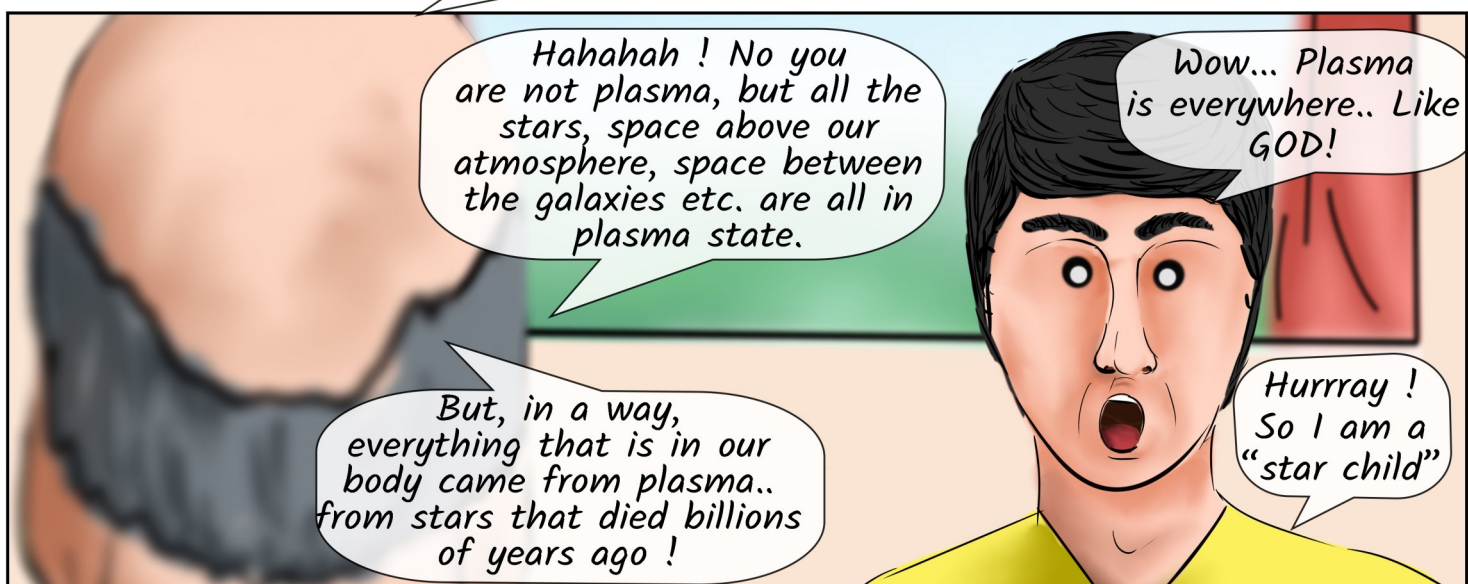
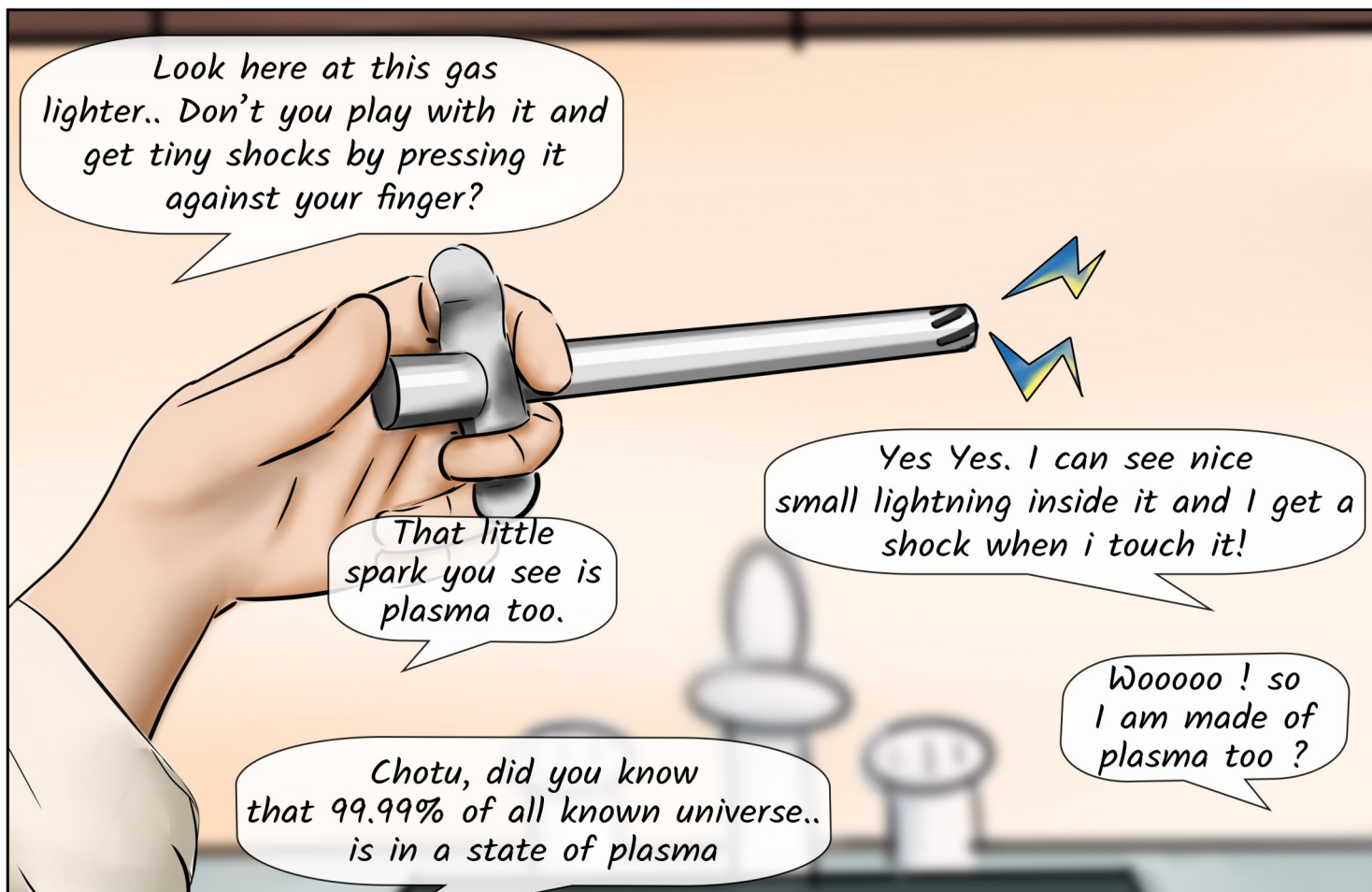
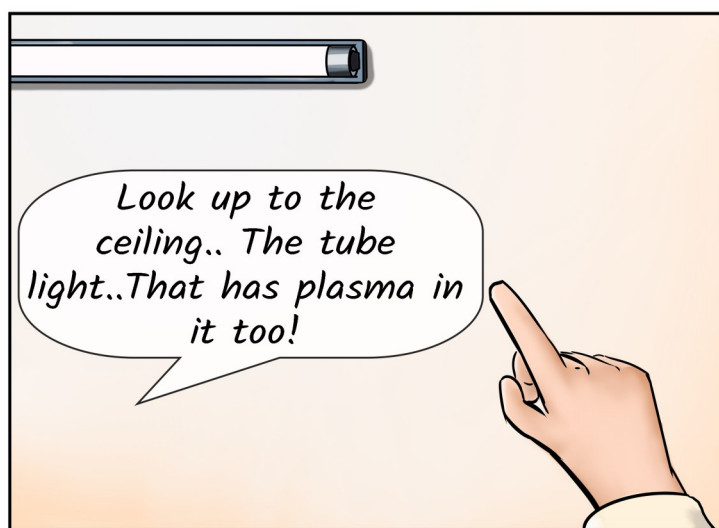


The **oxygen** and **hydrogen** will take energy from the high temperature and split into ions and electrons. Now, if we continue giving the heat, the ions and electrons will remain in that state and we now have no water, but a mixture of **Hydrogen** & **Oxygen** "PLASMA".




But Grandpa, if plasma is everywhere, why can't I see it ?










So like ice, water and steam, can we see and touch all Plasma ?

Well, you can see it, but not like how you see ice, water and steam. Didn't I tell you that plasma has ions and electrons?.



.. millions of them moving like crazy bees in this crazy flight!



Also, some plasma can be very hot and some at room temperature too, depending on how it is made !

Some of the ions will eventually hit an electron and they re-join to become the atom from which they originally formed. When they do that, they give out energy, some of it in the form of **light**, which we can see.

But what has all this got to do with our sun Grandpa?



Ahh yes.. I almost forgot all about that !

So, in the center of our sun, the temperature is so high that **hydrogen** there gets converted to **PLASMA**!

This plasma in the centre of the sun is so hot and dense that it fuses hydrogen to make **Helium**, producing huge amounts of **energy**.



**Energy**

This massive engine inside our sun is called "**Nuclear Fusion**"

Sooooo much happening on the sun that we don't know about!



Well, Chotu, It is the same plasma that runs the sun's engine and produces all the energy needed for our solar system!

To make all this energy, Our sun burns 600 billion kilograms of hydrogen every second to produce 38,460 septillion watts of energy per second!

3846000000

This is 3.846 followed by 26 zeros!

Ohhhhhh... I don't even know numbers more than 100!

Nooo.. I will take bath only in water!

Come on, time for your bath and today u will take a bath using liquid **Dihydrogen Monoxide\***...  
HAHAHA!!!

\*H<sub>2</sub>O (Water)

**THE  
END**



# INTERESTING FACTS ABOUT PLASMA

99.999 % of the known universe is in the state of plasma!

Comets and planetary rings have dusty plasma.

Plasma based ion-engines can take a spacecraft to Mars in 40 days !

Plasma can exist at temperatures very close to absolute zero to more than 5 trillion degrees C

Plasma is seen all around us ; in lightning, aurora, fluorescent tubes, flames, electric sparks etc.

About 1 kg of cold plasma escapes from earth's atmosphere every second

Plasma reacts strongly to electric and magnetic fields and hence can be controlled by them

Earth's small magnetic field protects us from sun's dangerous charged particles

Plasma has several applications in agriculture, engineering, electronics, medicine, textiles, waste management, aerospace etc

Cold plasma is the most effective anti-bacterial agent that is not harmful to our skin

Plasma can conduct electricity better than copper!

One small lightning has enough power to light a 60W bulb for 6 months

Plasma is used in nuclear fusion machines to generate temperatures more than 10 times that in the sun's core.



# Famous Plasma Physicists





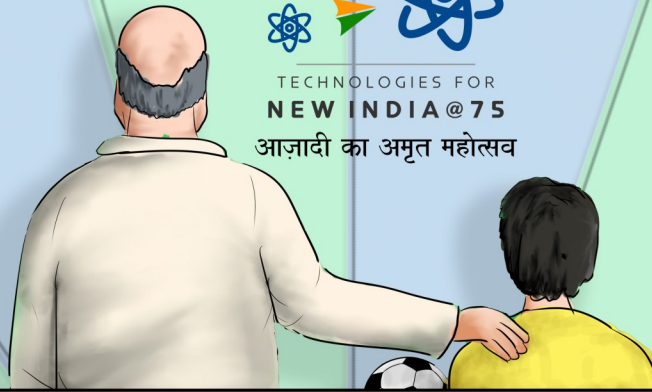
# "THE WONDERFUL WORLD OF PLASMA" COMIC SERIES NO.1

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TECHNOLOGIES FOR  
NEW INDIA @ 75

आज़ादी का अमृत महोत्सव



The Institute for Plasma Research (IPR) is located in on the banks of the river Sabarmati, near Indira Bridge, Gandhinagar, Gujarat. Established in 1986, it is an aided R&D institute under the Department of Atomic Energy (DAE).

The Institute is engaged in basic and applied research in Plasma Sciences and Technologies with a mandate to develop expertise and technologies for Nuclear Fusion as a source of Energy. The Institute has a vibrant research programme that includes many small experiments, two major Tokamak experiments and theoretical and computational studies in many areas of plasma physics. The tokamak experiments include India's first indigenous tokamak, "Aditya", which has been in operation since 1990. The second is the Steady-State Superconducting Tokamak (SST-2). IPR is the Indian nodal agency for its participation in the international fusion mega-project called ITER being built in France. Accordingly, the Institute has initiated a major programme in development of Fusion related technologies. Apart from the focus area of Fusion science & technology, the Institute is actively engaged in developing plasma-based technologies for industrial and societal applications. IPR is also one of the participating institutions for the LIGO-India project.



A scientific outreach activity of  
Institute for Plasma Research to commemorate  
75 Years of India's Independence



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