

# 50 IMPORTANT TOPICS

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# Omisure

- Omisure – India’s first home-grown testing kit – can **differentiate the omicron strain of the novel coronavirus from the delta, alpha** and the other variants in under four hours.
- It is an **omicron detecting RT-PCR kit** developed by the Mumbai-based Tata Medical and Diagnostics Ltd (TATA MD) in partnership with the Indian Council of Medical Research (ICMR).
- The kit recently received **approval from the Drugs Controller General of India.**
- Globally, all other test kits for omicron are either made for gene dropout or mutation-specific detection. Omisure is the first test kit combining both

# How does Omisure work?

- This new kit can identify the Omicron variant **by targeting two regions of the S or the spike gene**. This gene codes for the spike protein, which helps the novel coronavirus enter and infect human cells.
- **The S, the Enveloped (E), and Nucleocapsid (N) genes are some of the targets of conventional RT-PCR tests**. When it detects these genes, a patient sample is labelled positive.
- As omicron bears **heavy mutations in the S gene**, the RT-PCR can sometimes miss it.
- The absence of **S gene likely indicates omicron's presence**. This is called **S gene dropout or S gene target failure** – and is one of the targets of Omisure.
- This kit also depends on a second target: **S gene mutation amplification, which detects mutations explicitly in the S gene**.

# How does Omisure compare with gene sequencing?

- **Gene sequencing** reads the order of nucleotides, which are the building blocks of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).
- Despite being considered the gold standard, sequencing has a few limitations. It is **slow, expensive and complicated**.
- It is a **multi-step process**. It begins with extracting the virus' RNA from patient samples, converting it into DNA, amplifying or multiplying it through RT-PCR before finally **sending it for gene sequencing**.
- Identifying variants through gene sequencing can take as many as **three days**.
- **Omisure**, on the other hand, will do test the Omicron variant in **four hours**

# How does Omisure compare with gene sequencing?

- Gene sequencing is also complicated and expensive. It has to be done in batches of 24, 96 or 384. Testing 384 samples on one sequencing chip “costs around Rs 10,000 per sample. The cost is higher when the number of samples is lower
- A single kit of **Omisure** will reportedly cost Rs 250 for the laboratory.

# How accurate is this new kit?

- ICMR's evaluation showed that the kit picked up all sequence samples with **100 per cent accuracy**.
- The Pune-based National Institute of Virology has independently validated the kit



# SGTF strategy

- Researchers are pitching for genome sequencing of positive samples using RT-PCR kits that employ 'S' Gene Target Failure (SGTF) strategy to detect the variant.
- For example, 'S' Gene, ORF, 'N' gene, RdRp, 'E' gene etc are viral genes that are targeted to detect COVID-19 virus, and multiple genes make up the genetic structure of SARS-Co V-2.
- In case of Omicron variant, the 'S' gene is not getting detected in Thermofisher's Taq Path RT-PCR test due to mutation in the gene, while other gene targets such as ORF gene and N gene are getting detected, he said.
- "The occurrence is called as '**S' Gene Target Failure (SGTF) positive** cases. Such samples can be presumptively reported as Omicron positive and can be sent for fast-track genome sequencing for confirmation

# SGTF strategy

- The SGTF strategy focuses on taking those positive samples in which the RT-PCR test result shows **'S' Gene negative result, but ORF and N gene are positive.**
- The SGTF strategy will work as a kind of early detection at RT-PCR stage, and will help in screening COVID-19 positive samples of Omicron variant

# UV-C technology

Union Minister of State for Science and Technology has said that **Ultraviolet-C or UV-C Disinfection Technology will be installed in Parliament** for the “mitigation of airborne transmission of SARS-COV-2

## UV-C technology

- The UV-C air duct disinfection system was developed by **CSIR-CSIO** (Central Scientific Instruments Organisation)
- The system is designed **to fit into any existing air-ducts** and the virucidal dosages using UV-C intensity and residence time can be optimised according to the existing space.
- The **virus is deactivated** in any aerosol particles by the calibrated levels of UV-C light.
- It can be used in **auditoriums, malls, educational Institutions, AC buses, and in railways.**

# UV-C technology

## What is UV?

- Ultraviolet (UV) is a type of light or radiation naturally emitted by the Sun. It covers a **wavelength range of 100-400 nm**.
- The human visible light ranges from 380–700 nm.
- UV is divided into three bands: **UV-C (100-280 nm), UV-B (280-315 nm) and UV-A (315-400 nm)**.

# UV-C technology

## UV-A/B/C

- **UV-A and UV-B rays from the Sun** are transmitted through our atmosphere and all **UV-C is filtered by the ozone layer.**
- **UV-A rays** can penetrate the middle layer of your skin or the dermis and can cause aging of skin cells and indirect damage to cells' DNA
- **UV-B rays** can only reach the outer layer of our skin or epidermis and can cause sunburns and are also associated with skin cancer.
- **UV-C radiation from man-made sources** has been known to cause **skin burns and eye injuries.**

# UV-C technology

## Can UV-C kill coronavirus ?

- **UV-C radiation** (wavelength around 254 nm) has been **used for decades to disinfect the air** in hospitals, laboratories, and also in water treatment.
- But these conventional germicidal treatments are done in unoccupied rooms as they can **cause health problems**.
- A **paper published in June 2020** in Scientific Reports noted that UV-C radiation can **destroy the outer protein coating of the SARS-Coronavirus**

# UV-C technology

## Harmful effects

- Researchers from the **Indian Institute of Technology-Kanpur**, who developed a portable disinfectant device that used **UV-C radiation** (222-254 nm), noted that the device was specifically **developed to disinfect non-living things**.
- UV-C radiation used in this device **could be harmful to the skin and eyes of the living beings**, therefore the operator of the device must use spectacles with UV-C radiation protection and use this device safely
- It can take **hours to get sunburn from UV-B**, but with **UV-C it takes seconds**

# UV-C technology

## Not harmful

- The release from our **Ministry of Science and Technology** does not state the wavelength or duration used, but mentioned that the **product was tested for more than 99% disinfection.**
- Few studies have shown that **far-UVC light (207-222 nm)** does not **harm mammalian skin.**
- Far-UVC light has a very limited range and **cannot penetrate through the outer dead-cell layer of human skin** or the tear layer in the eye, so it's not a human health hazard.
- But because **viruses and bacteria are much smaller than human cells,** **far-UVC light can reach their DNA and kill them**

# Why do we care about atmospheric ozone?

400 nm

UV-A  
Long wave

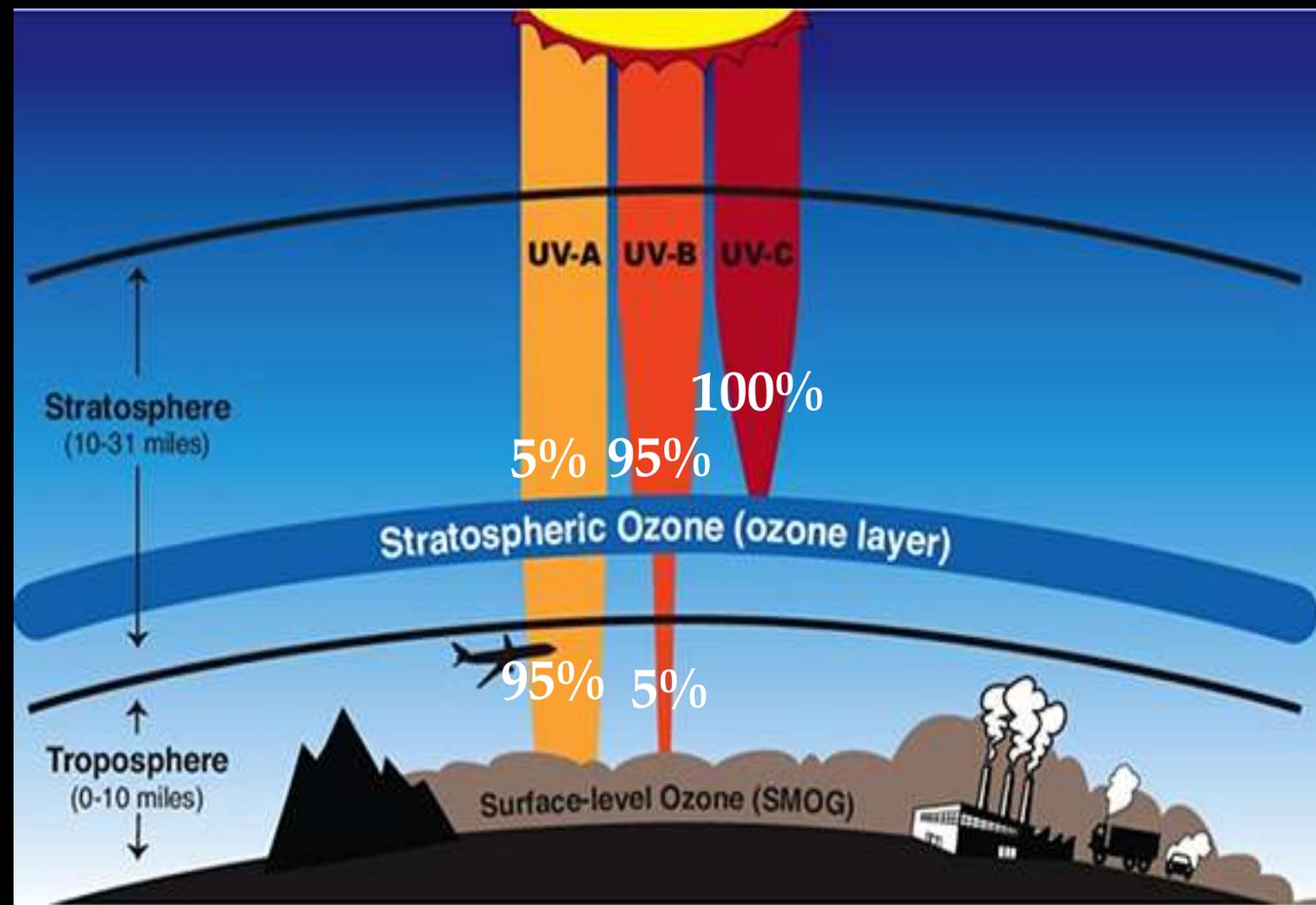
315 nm

UV-B  
Small wave

280 nm

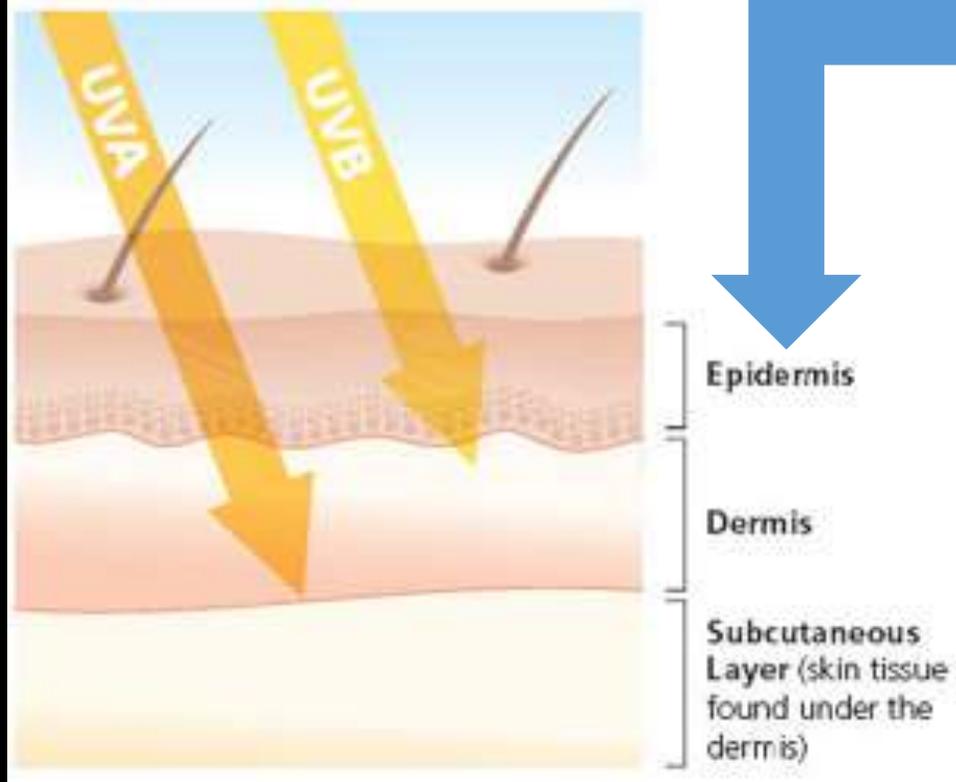
UV-C  
Shortwave

200 nm

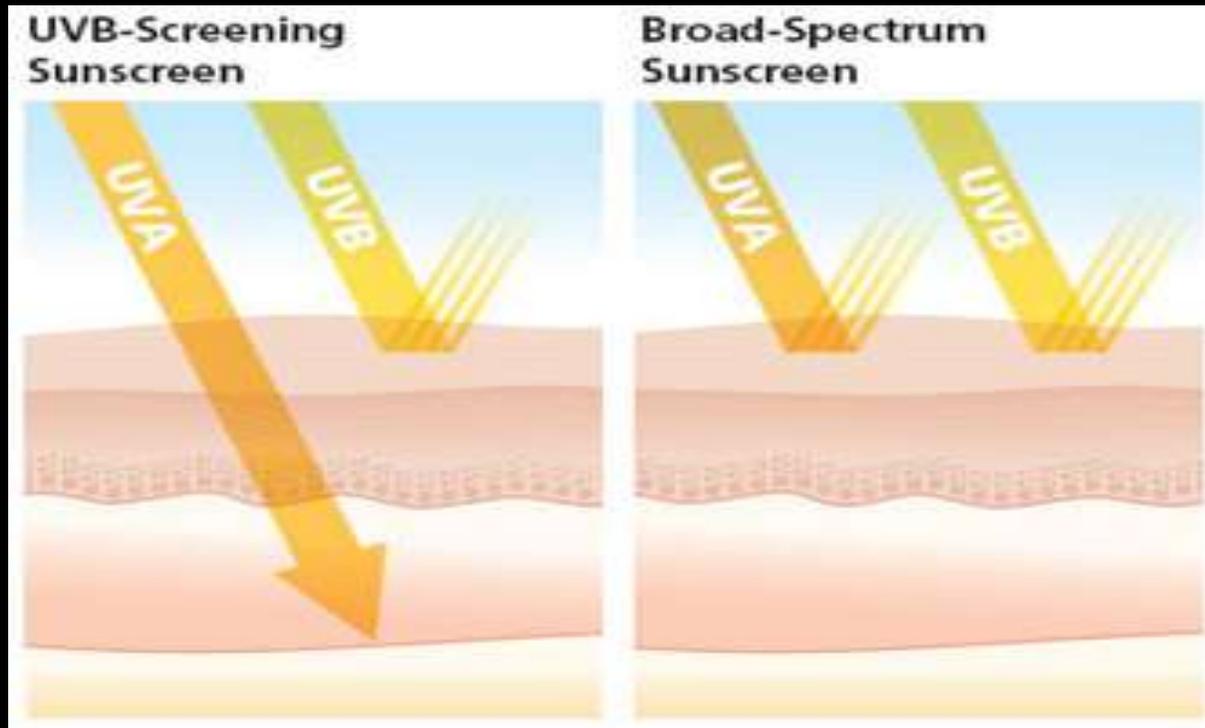


# UV-A or UV-B which is more dangerous?

UV Radiation and the Skin



Max Skin Cancer



# Germicidal -UV C



- Air disinfection
- Water disinfection
- Waste water treatment
- Aquarium and Pond
- Food and Beverage

Process

Destroy DNA

Sterile

Can't reproduce

# Havana Syndrome

- Some of the 1,000 US diplomats and intelligence officers hit by a mysterious illness known as **Havana Syndrome** could have been targeted by **electromagnetic energy pulses**, according to a report
- The problem has been labeled the "Havana Syndrome," because the first cases **affected personnel in 2016 at the U.S. Embassy in Cuba**
- They experienced some **odd physical sensations** and heard **peculiar sounds**, after which they **started feeling sick**
- The **US** had even **accused Cuba** of carrying out **sonic attacks**. But Cuba denied the accusations of the sonic attacks and refused awareness of any such illness or syndrome.
- The symptoms of the syndrome include **Nausea, Severe headaches, Fatigue, Dizziness, Sleep problems, Hearing loss**

# Havana Syndrome

## Microwave Weapons

- Microwave weapons are supposed to be a type of direct energy weapons, which aim highly focused **energy in the form of sonic, laser, or microwaves, at a target.**
- It uses a focussed beam of high-frequency electromagnetic radiation to **heat the water in a human target's skin**, causing pain and discomfort.

## Which countries have these microwave weapons

- According to a report, **China** had first put on display its “microwave weapon”, called **Poly WB-1**, at an air show in 2014.
- The United States has also developed a prototype microwave-style weapon, which it calls the “**Active Denial System**”.

# Havana Syndrome

## India

- Recently, the Defence Research and Development Organisation (DRDO) has announced its plans to develop (DEWs) using high-energy lasers and microwaves.

## Concerns

- Concerns have been raised on whether they can damage the eyes, or have a carcinogenic impact in the long term.
- It is not clear yet how China intends to use such a weapon, and whether it can kill or cause lasting damage to human targets.

# Pain without injury

The 'Active Denial System' deters attackers by sending a non-lethal millimeter-wave of electromagnetic energy, causing a burning sensation.

**Wave Penetrates** the skin to 1/64 of an inch, causing a feeling similar to being on fire



Two-second burst can heat skin to 130° F

98.6° F Normal



**Antenna** focuses the invisible energy

Note: Drawing is schematic

**Transmitter** Produces 95 GHz frequency waves

122° F People pull away reflexively

# Fragile X syndrome(FXS)- (TH)

In 2017, a man in Delhi, affected by autism, underwent his first DNA blood test at the age of 40. He tested positive for **Fragile X Syndrome (FXS)**.

## **Fragile X Syndrome (Martin-Bell syndrome or Marker X syndrome)**

- Fragile X syndrome (FXS) is a genetic disorder.
- **Cause** : FXS is caused by changes in a gene that scientists called *FMR1* gene when it was first discovered.
- The *FMR1* gene usually makes a protein called FMRP. FMRP is needed for brain development. People who have FXS do not make this protein.
- It affects **both males and females**. However, females often have milder symptoms than males
- **The syndrome is the leading inherited cause of autism** in 4% of the population worldwide.
- It is largely undetected in India

# Fragile X syndrome(FXS)- (TH)

## Signs and Symptoms

- Developmental delays (not sitting, walking, or talking at the same time as other children the same age);
- Learning disabilities (trouble learning new skills)

# Mosquitoes To Combat Dengue

- Recently, **Researchers in Indonesia** have found a way to fight disease-bearing mosquitoes by breeding a species of insect which carries **Wolbachia bacteria**.
- Wolbachia is a common bacterium that **occurs naturally in 60% of insect species**, including some mosquitoes, fruit flies, moths, dragonflies, and butterflies.
- It is **not found in dengue-carrying Aedes aegypti mosquitoes**, the primary species responsible for transmitting human viruses such as Zika, dengue, chikungunya, and yellow fever.

# Mosquitoes To Combat Dengue

- The lab-bred mosquitoes with **Wolbachia** will mate with mosquitoes **with dengue**, which will produce Wolbachia mosquitoes ('good' mosquitoes).
- Wolbachia bacteria in the mosquitoes **prevent viruses like dengue from growing inside them.**
- Wolbachia method helps to **protect communities from mosquito-borne diseases like Zika, dengue, chikungunya, and yellow fever** and does so without posing a risk to natural ecosystems or human health.

# Mosquitoes To Combat Dengue

- The dengue vaccine **CYD-TDV** or **Dengvaxia** was approved by the **US Food & Drug Administration in 2019**, the first dengue vaccine to get the regulatory nod in the US. Dengvaxia is basically a live, attenuated dengue virus that has to be administered in people of ages 9 to 16 who have laboratory-confirmed previous dengue infection and who live in endemic areas.

**1** Mosquitoes are **injected with a homing gene** using a tiny needle



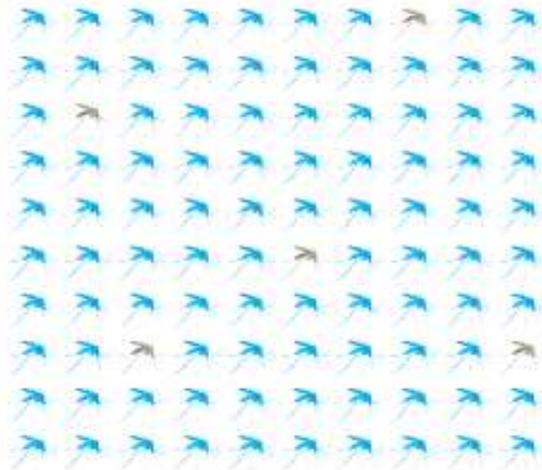
**2** The gene locks on to a sequence in **the X chromosome**



**3** That part of the X chromosome is **'shredded'**



**4** This favours unaffected sperm-bearing Y chromosomes, meaning their **offspring become 95% male**



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Mosquitoes without *Wolbachia* transmit Zika and dengue



Mosquitoes with *Wolbachia* block transmission of Zika and dengue

**Control strategy 1:**

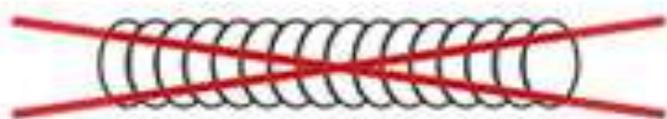
Directly insert incompatibility genes into male mosquito genome



Released male with incompatibility genes



Wild female



Resulting eggs do not hatch, which crashes the local population

**Control strategy 2:**

Insert extra incompatibility genes into *Wolbachia*



Released male with extra incompatibility genes



Wild female



Local population crashes

# Merger of supermassive black holes

Indian researchers have discovered **three supermassive black holes** from three galaxies merging together to form a **triple active galactic nucleus (AGN)**

## About

- Scientists were studying the **AGN** in the two massive barred spiral galaxies **NGC7733** and **NGC7734** when they **detected unusual emissions from the centre of the latter and a curious movement of a large bright clump within it**, having a different velocity than that of **NGC7733**.
- As the third one was a separate galaxy, the scientists named it **NGC7733N**.
- All **three merging black holes were part of galaxies in the Toucan constellation**

# Merger of supermassive black holes

## Merger

- According to the researchers, a major factor impacting galaxy evolution is galaxy interactions which happen when galaxies move close to each other and **exert tremendous gravitational forces on each other.**
- During such galaxy interactions, the respective **supermassive black holes can get near each other.**
- The **dual black holes start consuming gas from their surroundings and become dual AGN.**
- If two galaxies collide, their black holes will also come closer by **transferring the kinetic energy to the surrounding gas.**

# Merger of supermassive black holes

- The **distance between the blackholes decreases** with time until the separation is around a **parsec (3.26 light-years)**.
- The two black holes are then unable to lose any further kinetic energy in order to get even closer and merge. This is known as the **final parsec problem**.
- The presence of a **third black hole can solve** this problem.
- The **dual merging blackholes can transfer their energy** to the third blackhole and merge with each other
- Many AGN pairs have been detected in the past, but **triple AGN are extremely rare**, and only a handful has been detected before using X-ray observations.
- However, scientist expects such **triple AGN systems to be more common in small merging groups of galaxies**.



# Semi-Cryogenic Propellant Tank

## Context

Hindustan Aeronautics Ltd (HAL) **delivered the heaviest semi-cryogenic propellant tank (SC120- LOX)** to the Indian Space Research Organization (ISRO).

## About

- The **semi cryo-liquid oxygen (LOX) tank** - the first developmental welded hardware - is a **part of the SC120 stage** intended for payload enhancement by replacing the L110 stage in the existing Mk-III launch vehicle.
- A **cryogenic engine/cryogenic stage** is the last stage of space launch vehicles which makes use of Cryogenics.
- **Cryogenics is the study of the production and behaviour of materials at extremely low temperatures** (below -150 degree Centigrade) to lift and place heavier objects in space.

# Semi-Cryogenic Propellant Tank

- A **cryogenic engine** provides more force with each kilogram of cryogenic propellant it uses compared to other propellants, such as solid and liquid propellant rocket engines and is more efficient.
- It uses **Liquid Oxygen (LOX)** and **Liquid Hydrogen (LH2)** as propellants which liquefy at  $-183$  deg C and  $-253$  deg C respectively.

# Semi-Cryogenic Propellant Tank

## Cryogenic Vs Semi cryogenic engine

- Unlike a Cryogenic engine, a **Semi Cryogenic engine uses Refined kerosene instead of liquid hydrogen.**
- The **liquid oxygen is used as a Oxidiser.**
- That's the advantage of using a Semi Cryogenic engine as it requires **Refined Kerosene which is lighter than liquid fuel** and can be stored in a normal temperature.
- **Kerosene combined with liquid oxygen provide a higher thrust to the rocket.**
- **Refined Kerosene occupies less space**, making it possible to **carry more propellant in a Semi Cryogenic engines fuel compartment.**
- A semi cryogenic engine is more powerful, environment friendly and cost effective as compared to a cryogenic engine.

# Fast Radio Bursts

## Context

Researchers from the **Pune-based Tata Institute for Fundamental Research (TIFR)** and the National Centre for Radio Astrophysics (NCRA), have assembled the **largest collection of Fast Radio Bursts (FRBs) catalogue.**

- The data is from **Canadian Hydrogen Intensity Mapping Experiment (CHIME).**
- In 2020, **NASA spotted FRB for the first time in the Milky Way.**
- The new catalogue expands the current library of known FRBs, and is already helping in understanding their properties.

# Fast Radio Bursts

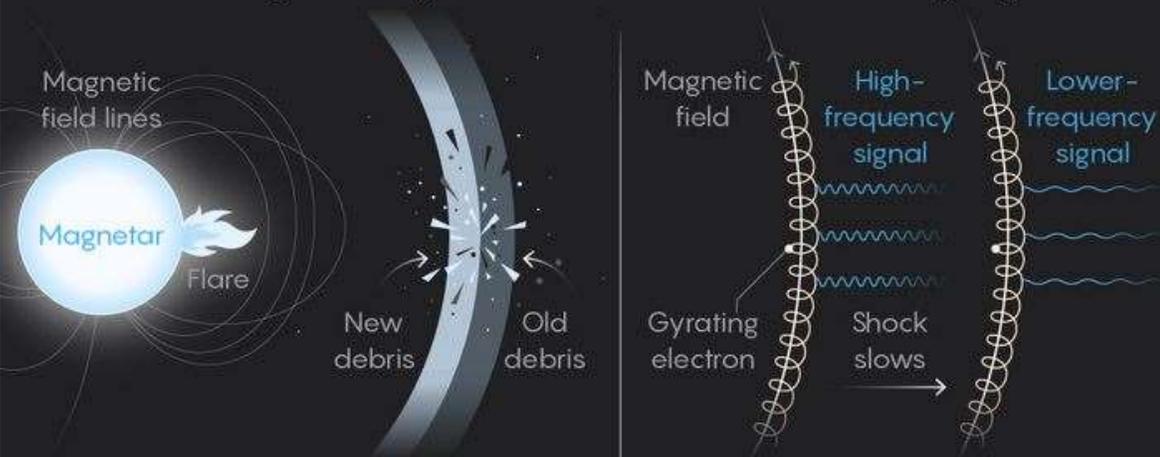
## Fast Radio Bursts

- FRB are **bright bursts of radio waves** (radio waves can be produced by **astronomical objects with changing magnetic fields**) whose durations **lie in the millisecond-scale**, because of which it is **difficult to detect them and determine their position in the sky**.
- It was first discovered in 2007.
- A defining property of these bursts is their dispersion (scattering or separation), the bursts produce a spectrum of radio waves, and as the waves travel through matter, they spread out or disperse with bursts at higher radio frequencies arriving at telescopes earlier than those at lower frequencies.

# Fast Radio Bursts

## How Fast Radio Bursts Work

Fast radio bursts are brief, energetic blips of radio waves that originate far across the universe. At least one repeats, which has added to the challenge of explaining what might be creating them. A new model accounts for past observations and predicts specific features that should be seen going forward.



**1** A magnetar releases a flare of electrons and other charged particles.

**2** The flare collides with the remnants from an old flare, creating huge magnetic fields.

**3** In the ensuing shock, gyrating electrons generate energetic radio waves. As the shock slows, the radio signal downshifts to lower frequencies.

# Fast Radio Bursts

## About CHIME

- It is a **novel radio telescope that has no moving parts.**
- **It is optimized to have a high mapping speed.**
- It is located at the Dominion Radio Astrophysical Observatory, Canada.

# Fifth State of Matter

## Context

- NASA scientists on Earth have collaborated with astronauts on the International Space Station (ISS) to corral the first ever Bose-Einstein condensate (BEC)- the fifth state of matter- outside of Earth's gravity.
- The matter has been created in one of the coldest places in the universe- the **Cold Atom Laboratory**- a device on board the International Space Station (ISS).

# Fifth State of Matter

## Five states of matter

- There are four natural states of matter: Solids, liquids, gases and plasma.
- The **fifth state is the man-made Bose-Einstein condensates.**

## About Bose-Einstein condensate

- BEC are formed when the atoms of certain elements are **cooled to near absolute zero (0 K or  $-273.15^{\circ}\text{C}$ ).**
- At this point, atoms become a **single entity** with quantum property, **whereas each particle also functions as a wave of matter.**
- Scientists have believed that BECs contain **vital clues to mysterious phenomena such as dark energy which is unknown energy thought to be behind the Universe's accelerating expansion.**

# Fifth State of Matter

- These are **extremely fragile and the slightest interaction with the external world is enough** to warm them past their condensation threshold.
- Because of this condition, **it becomes nearly impossible for scientists to study BECs on Earth as gravity interferes with the magnetic field required to hold them in place for observation.**
- BECs in terrestrial lab generally last a handful of milliseconds before dissipating while aboard ISS, those lasted more than a second.
- Studying BECs in microgravity has opened up a host of opportunities.

# Fifth State of Matter

- The existence of **Bose-Einstein condensates (BEC)** was predicted by an **Indian mathematician Satyendra Nath Bose** and **Albert Einstein** almost a century ago.

# India's second rocket launch pad

## Context

India's second rocket launch pad is being setup in Thoothukudi (formerly known as Tuticorin) district in Tamil Nadu.

- The project will house one launch pad **exclusively for small satellite launch vehicles (SSLV)**.
- India presently has **one rocket port at Sriharikota in Andhra Pradesh with two launch pads**.

# India's second rocket launch pad

## Why was Thoothukudi chosen?

- Proximity to the seashore makes Thoothukudi ideal for “straight southward” launches.
- From Sriharikota, such southward bound launches are **not possible as the rockets have to fly around Sri Lanka.**
- Like the Sriharikota spaceport in the Satish Dhawan Space Centre, Thoothukudi was selected as a spaceport **due to its nearness to the equator.** A rocket launch site should be on the east coast and near the equator.
- ISRO has its **Liquid Propulsion Systems Centre (LPSC) at Mahendragiri in Tirunelveli district,** where it assembles the second and fourth stage engines for the PSLV.
- Instead of transporting the second and fourth stages to Sriharikota from Mahendragiri, it would **be easier to shift them to the launch pad if it is built in Kulasekarapattinam,** which is around 100 km away.

# India's second rocket launch pad

## Proximity to Earth's equator

- India prefers its spaceports as close to the equator as possible and located on the east coast **for two reasons:**
  1. **Earth's rotation provides a speed boost** to rockets launched and strength of the boost is higher closer to the equator.
  2. In the event of a failure, **debris from an explosion would fall into the Bay of Bengal** instead of land, potentially saving property and lives.

# New Source of Gravitational Waves Discovered

## Context

**LIGO Scientific Collaboration (LSC)** has made the discovery of gravitational waves from a pair of neutron star-black hole (NS-BH) mergers.

- There is huge excitement among scientists with the first confirmed detection of a neutron star-black hole (NS-BH) collision being reported.
- Widely unequal mergers have very interesting effects that can be detected.
- This ground breaking discovery of gravitational waves from a pair of NS-BH mergers.
- Until now, the **LIGO-Virgo collaboration (LVC)** of gravitational waves detectors has only been able to observe collisions between pairs of black holes or neutron stars.

# New Source of Gravitational Waves Discovered

## Neutron Stars

- Neutron stars comprise one of the possible evolutionary end-points of high mass stars.
- Once the core of the star has completely burned to iron, energy production stops and the core rapidly collapses, **squeezing electrons and protons together to form neutrons and neutrinos.**
- A star supported by neutron degeneracy pressure is known as a 'neutron star', which **may be seen as a pulsar if its magnetic field is favourably aligned with its spin axis.**

# New Source of Gravitational Waves Discovered

## Gravitational waves

- These are 'ripples' in space-time caused by some of the **most violent and energetic processes in the Universe**.
- Albert Einstein predicted the existence of gravitational waves in 1916 in his general theory of relativity.
- The strongest gravitational waves are produced by cataclysmic events such as **colliding black holes, supernovae (massive stars exploding at the end of their lifetimes), and colliding neutron stars**.
- Other waves are predicted to be caused by the **rotation of neutron stars that are not perfect spheres**, and possibly even the remnants of gravitational radiation created by the Big Bang.

# New Source of Gravitational Waves Discovered

## LIGO Scientific Collaboration (LSC)

- The LIGO Scientific Collaboration (LSC) is a scientific collaboration of international physics institutes and research groups dedicated to the search for gravitational waves.
- Established in 1997
- **HQ: California Institute of Technology and Massachusetts Institute of Technology, United States**
- On 11 February 2016, the LIGO and Virgo collaborations announced that they succeeded in making the first direct gravitational wave observation on 14 September 2015.

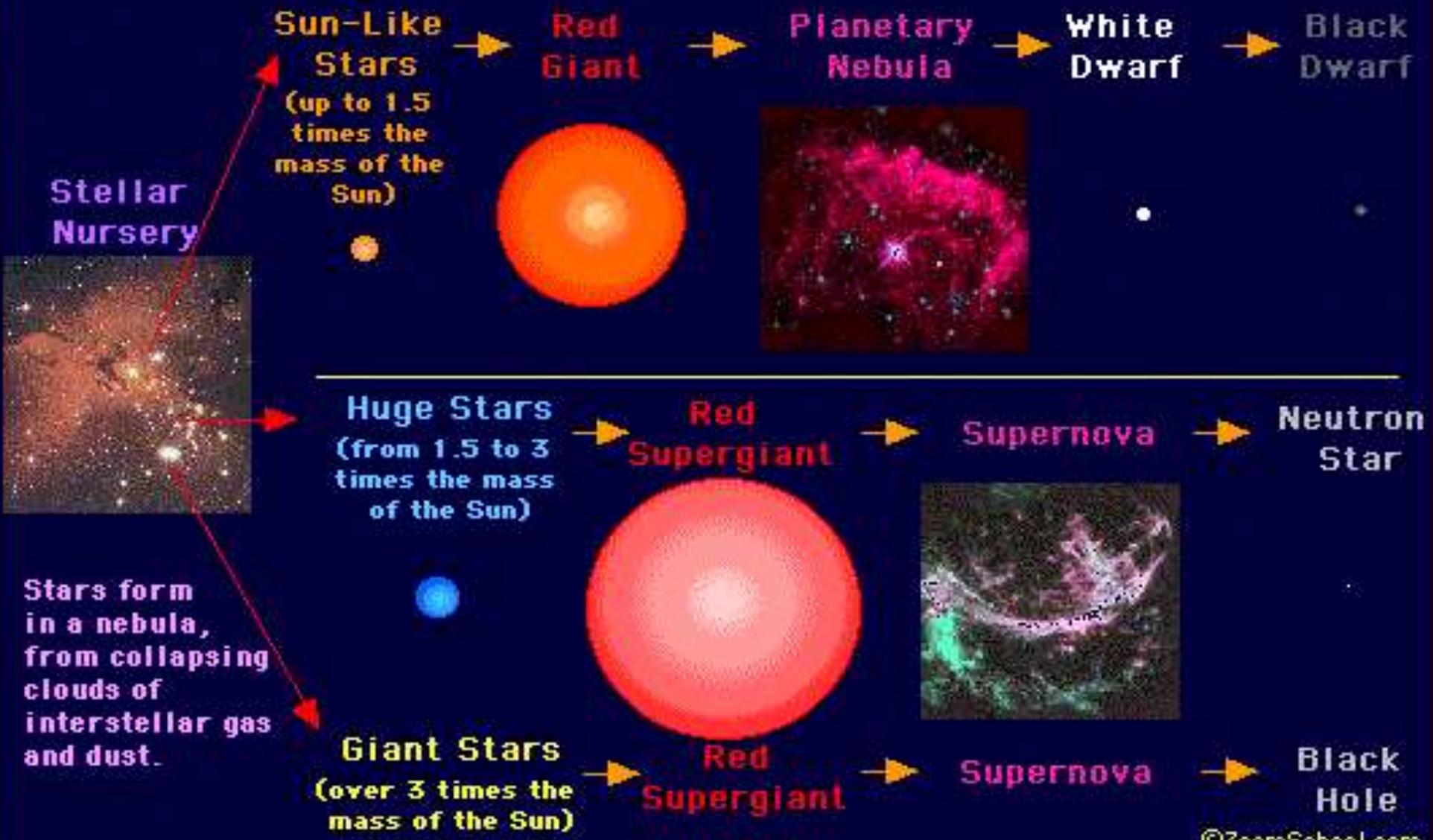
# New Source of Gravitational Waves Discovered

- The LSC is made up of around 1,400 scientists from 19 countries, and includes researchers from 11 UK universities including Strathclyde, Glasgow, Birmingham, Portsmouth and Cardiff.
- This project currently operates **three gravitational-wave (GW) detectors**. Out of three, **two are at Hanford** in Washington while **one is at Livingston** in Louisiana.

## LIGO India project

- The LIGO India project was proposed with the aim of moving one advanced LIGO detector to India, **from Hanford**. This project is piloted by **Department of Science and Technology (DST)** and **Department of Atomic Energy (DAE)**.

# The Lifecycle of Stars



©ZoomSchool.com

Protostar looks like a star but its core is not yet hot enough for nuclear fusion to take place

A red giant is formed when a star runs out of hydrogen at its core and starts fusing hydrogen into helium just outside the core releasing energy and expanding the star

Once the star runs out of fuel, the star will collapse under the influence of gravity and the outer layers will be ejected into the vastness of space

Small Star

Red Giant

Planetary Nebula

Remains of stars devoid of fuel. They consist of degenerate matter with a very high density.

White Dwarf

White dwarf becomes a black dwarf when it stops emitting light

Large Red giants are hot enough to turn the helium at their core into heavy elements like carbon

Protons and electrons left after a supernova are forced to combine to produce very dense neutron star.

Supernovae can be triggered by

- 1) by the sudden re-ignition of nuclear fusion in a degenerate star
- 2) by the gravitational collapse of the core of a massive star.

Supernova  
Explosive death of a star.

Neutron Star

If the mass is significantly greater, the gravity will be so strong that the neutron star will shrink further to become a black hole.

Red Supergiant

Large Star

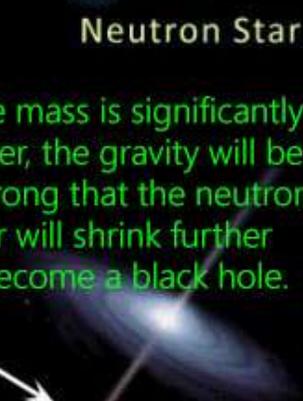
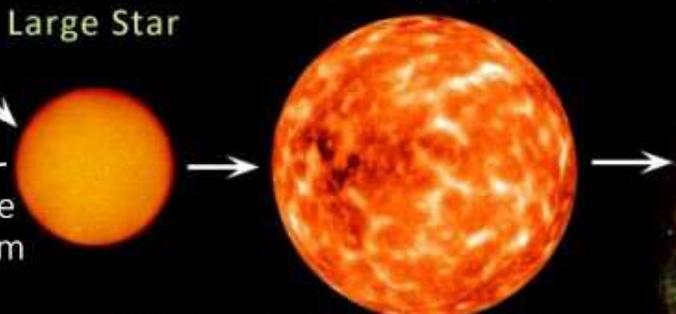
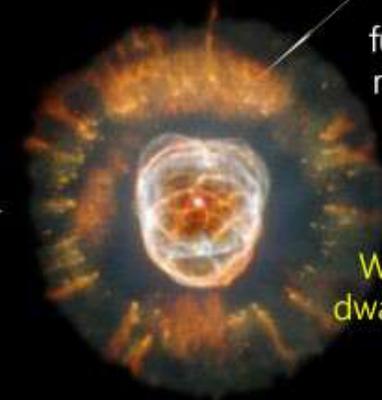
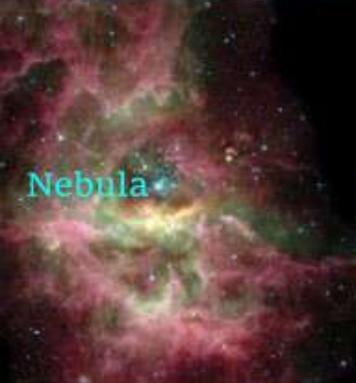
Black Hole

As the large red giant star condenses, it heats up even further, burning the last of its hydrogen and causing the star's outer layers to expand outward

Main sequence stars fuse hydrogen atoms to helium atoms in their cores



Nebula



# CMS- 01

## Context

- The Indian Space Research Organisation (ISRO) has launched a communications satellite, **CMS-01**, on board its **Polar Satellite Launch Vehicle (PSLV - C50)** from the Satish Dhawan Space Centre, Andhra Pradesh.

# ISRO'S PSLV-C50 LIFTS OFF WITH CMS-01 SATELLITE

PSLV-C50 successfully placed country's CMS-01 satellite into geosynchronous transfer orbit

- CMS-01 is India's 42nd communication satellite
- Will replace GSAT-12 satellite, launched in 2011
- Will provide telecom services in the Extended-C Band of the frequency spectrum
- Extended-C Band coverage will include Indian mainland, Andaman-Nicobar and Lakshadweep Islands
- Mission life: 7 years

## PSLV-C50

- **52nd** flight of PSLV
- **22nd** flight of PSLV 'XL' variant



**77th launch vehicle mission from Sriharikota spaceport**



Source: ISRO

-890-3043

# CMS- 01

## About CMS-01

- CMS-01 is a communications satellite envisaged for providing services in extended C Band frequency spectrum.
- Its coverage will include the **Indian mainland, and the Andaman & Nicobar and Lakshadweep islands.**
- The satellite is expected to have a life of more than seven years.
- The satellite was injected precisely into its predefined sub- **Geo-synchronous Transfer Orbit (GTO)**. Eventually, it will be placed into its specified slot in the Geo-Synchronous Orbit after a series of manoeuvres.
- CMS-01 will **replace and enhance the services of GSAT-12.**

# CMS- 01

## About GSAT-12

- GSAT-12, a communication satellite built by ISRO, provides facilities for various communication services like **Tele-education, Tele-medicine and for Village Resource Centres (VRC)**.
- To provide the space based services directly to the rural areas, ISRO has launched the Village Resource Centres (VRCs) programme in association with NGOs/Trusts and state/central agencies.

# ISRO's Shukrayaan

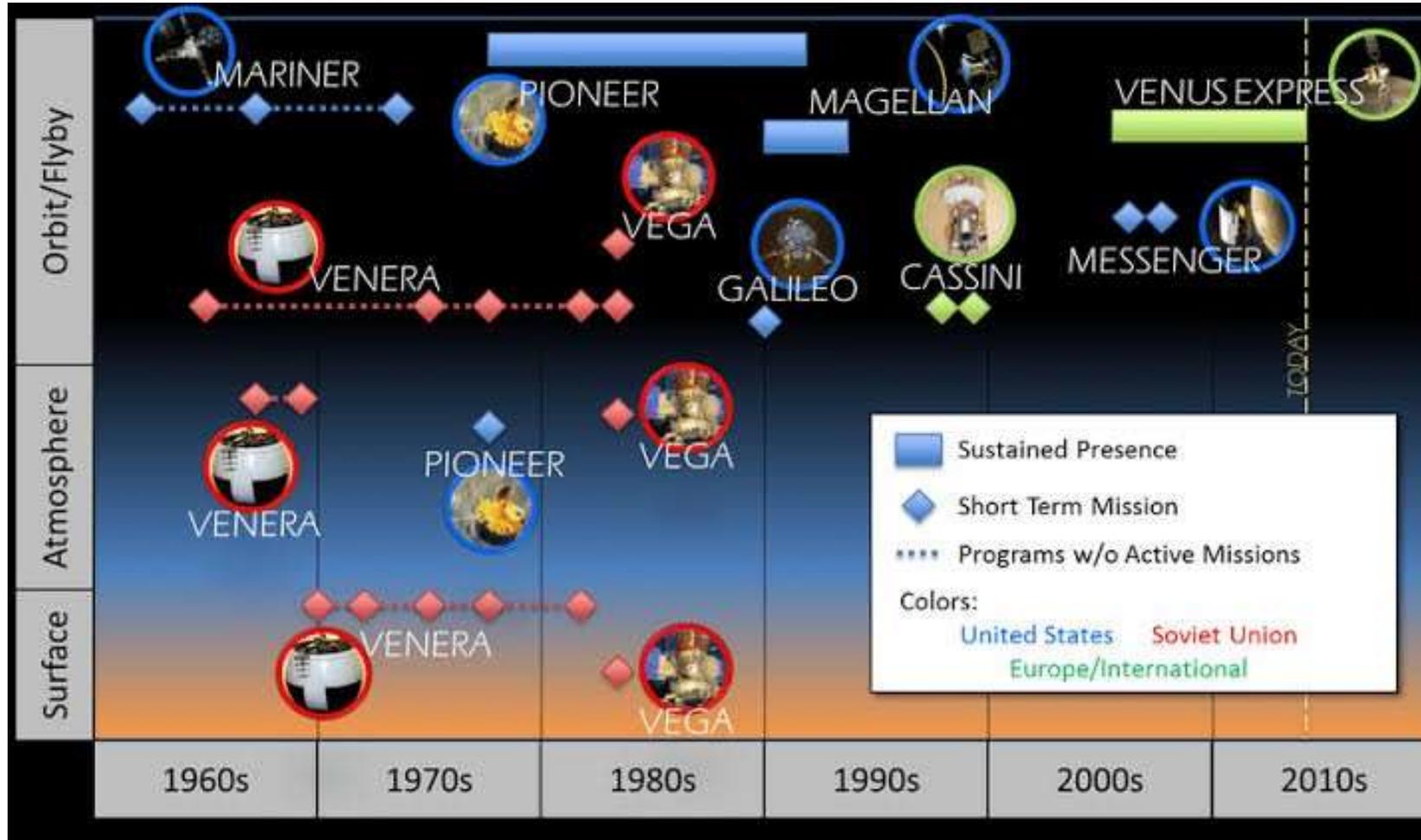
## Context

- The Indian Space Research Organisation (ISRO) has **short-listed 20 space-based experiment proposals for its proposed Venus orbiter mission 'Shukrayaan'**.

## About Shukrayaan

- It is a mission to **study Venus** for more than four years.
- Investigation of the **surface processes** and shallow subsurface stratigraphy; and **solar wind interaction with Venusian Ionosphere**, and studying the structure, composition and dynamics of the atmosphere are the scientific objectives of the mission.
- Shukrayaan is **set to launch on India's GSLV Mk II rocket**.

# ISRO's Shukrayaan



# ISRO's Shukrayaan

## About Venus

- Venus is the **second planet from the Sun** and is **Earth's closest planetary neighbor**.
- It's one of the four inner, terrestrial (or rocky) planets, and it's often called **Earth's twin because it's similar in size and density**. These are not identical twins, however – there are radical differences between the two worlds.
- Venus has a **thick, toxic atmosphere filled with carbon dioxide** and it's perpetually shrouded in thick, **yellowish clouds of sulfuric acid** that trap heat, causing a runaway greenhouse effect. It's the hottest planet in our solar system, **even though Mercury is closer to the Sun**. Surface temperatures on **Venus are about 900 degrees Fahrenheit** (475 degrees Celsius) – hot enough to melt lead.
- The surface is a rusty color and it's peppered with intensely crunched mountains and **thousands of large volcanoes**. Scientists think it's possible some volcanoes are still active.

# ISRO's Shukrayaan

- Venus has crushing **air pressure at its surface – more than 90 times that of Earth** – similar to the pressure you'd encounter a mile below the ocean on Earth.
- Another big difference from Earth – **Venus rotates on its axis backward, compared to most of the other planets** in the solar system. This means that, on **Venus, the Sun rises in the west** and sets in the east, opposite to what we experience on Earth. (It's not the only planet in our solar system with such an oddball rotation – **Uranus spins on its side**)

# ISRO's Shukrayaan

Venus was the first planet to be explored by a spacecraft – NASA's Mariner 2 successfully flew by and scanned the cloud-covered world on Dec. 14, 1962.

## Other Mission

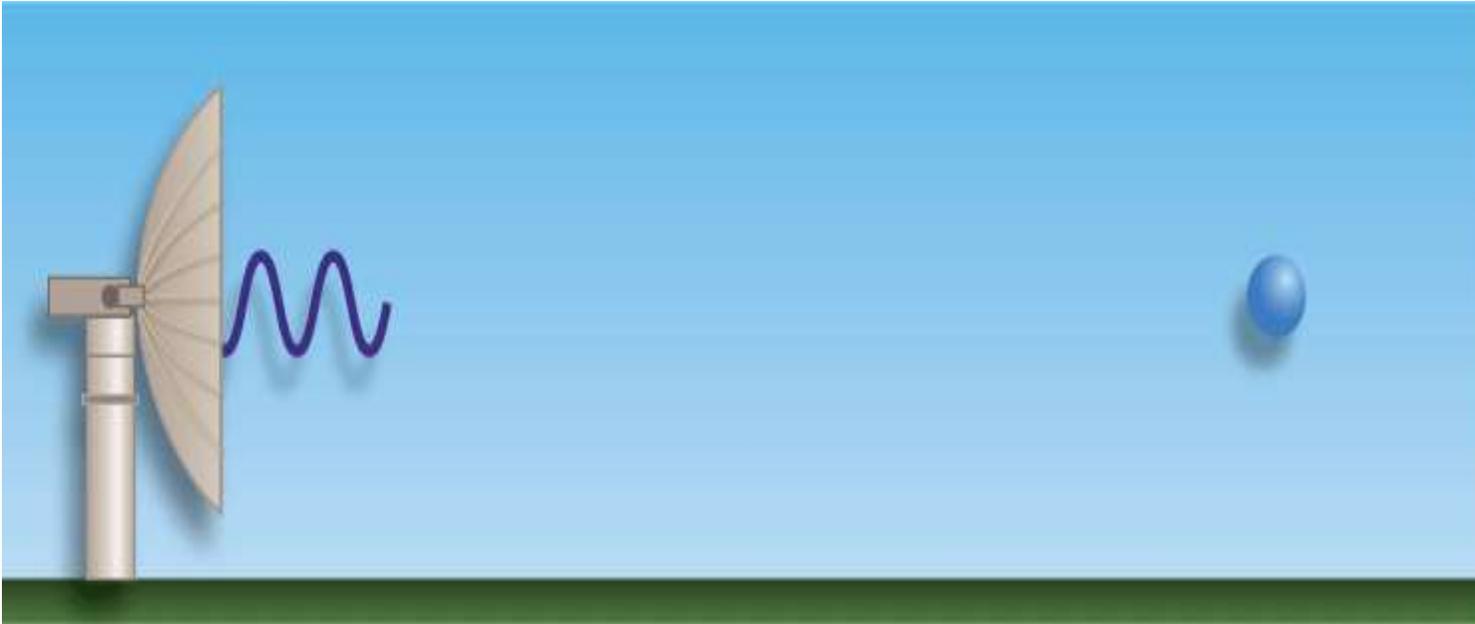
- NASA-Mariner, Pioneer , Magellan
- Russia- Venera, Vegas
- Japan-Akatsuki
- Europe-Venus express

In June 2021, three new missions to Venus were announced. NASA announced two new missions, and ESA announced one:

- NASA- VERITAS, DAVINCI
- ESA-EnVision

# Doppler Radar

- The India Meteorological Department (IMD) will install seven new doppler radars in Maharashtra, including Mumbai, this year



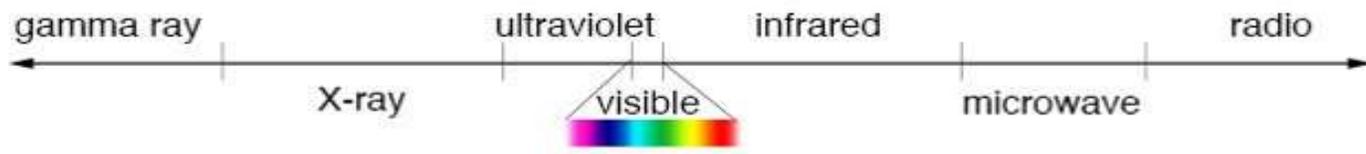
| Radar system                   |   |
|--------------------------------|---|
| <b>RADAR</b>                   | <ul style="list-style-type: none"><li>• Beam of energy, called <b>radio waves</b>, is emitted from an <b>antenna</b>. As they strike objects in the atmosphere, the energy is scattered in all directions with some of the energy reflected directly back to the radar.</li></ul>   |
| <b>Doppler radar</b>           | <ul style="list-style-type: none"><li>• specialized radar that uses the <b>Doppler effect</b></li><li>• <b>Doppler effect</b>-effect produced by a moving source of waves in which there is an apparent <b>upward shift in frequency</b> for observers towards whom the source is approaching and an apparent downward shift in frequency for observers from whom the source is receding.</li></ul> |
| <b>Weather radar principle</b> | <ul style="list-style-type: none"><li>• Weather detection is based on the <b>reflectivity of water droplets</b></li><li>• The weather radar echo returns vary in intensity as a function of the droplet size, composition and quantity.</li><li>• <b>Measure rainfall intensity, wind shear and velocity and locate a storm centre</b> and the direction of a tornado or gust front.</li></ul>      |

|  |               |  |
|--|---------------|--|
| <b>Bands</b>   | <b>X band</b> | <ul style="list-style-type: none"><li>• smaller wavelength, the X band radar is <b>more sensitive and can detect smaller particles.</b></li><li>• <b>detect thunderstorms</b> and lightning (Latest version)</li></ul> |
| <b>Wavelength</b> <ul style="list-style-type: none"><li>• <math>S &gt; C &gt; X</math></li></ul> | <b>C-band</b> | <ul style="list-style-type: none"><li>• Cyclone tracking</li><li>• Short range observation</li></ul>   |
| <b>Frequency</b> <ul style="list-style-type: none"><li>• <math>X &gt; C &gt; S</math></li></ul>  | <b>S-band</b> | <ul style="list-style-type: none"><li>• Far range observation</li></ul>  |

|              |  |
|--------------|--|
| About        | <ul style="list-style-type: none"><li>• Doppler radars of varying frequencies – S-band, C-band and X-band – are commonly used by the IMD to detect and track the movement of weather systems, cloud bands and gauge rainfall over its coverage area of about 500 km</li></ul>  |
| Significance | <ul style="list-style-type: none"><li>• With the radar observations, <b>updated every 10 minutes</b>, forecasters can accordingly predict weather events and their impact.</li><li>• Guide meteorologists in times of extreme weather events like <b>cyclones and associated heavy rainfall</b>.</li><li>• The radars can <b>oversee an area of up to 500 km</b>, with effective range of up to 250 km</li></ul> |

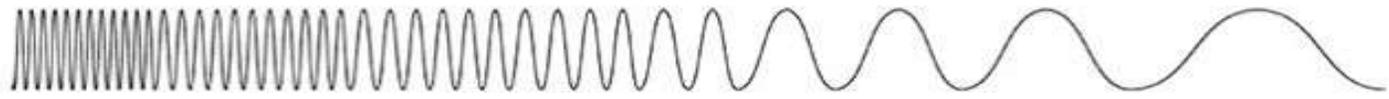
## Indian radar system

|              |  |   |
|--------------|--|---|
| Distribution | west coast   | At Thiruvananthapuram, Kochi, Goa and Mumbai  |
|              | East coast   | At eight locations – Kolkata, Paradip, Gopalpur, Vishakhapatnam, Machilipatanam, Sriharikota, Karaikal and Chennai.                 |
|              | Other  | Srinagar, Patiala, Kufri, Delhi, Mukteshwar, Jaipur, Bhuj, Lucknow, Patna, Mohanbar, Agartala, Sohra, Bhopal, Hyderabad and Nagpur. |
| Future       | The <b>modernisation and upgrade of existing radars</b> are ongoing and the IMD plans to have a network of 55 doppler radars<br><b>Four X-band</b> and <b>one C-band radar</b> will be deployed over Mumbai.<br>In addition, Ratnagiri will get a new C-band and Vengurla will get an X-band radar |   |



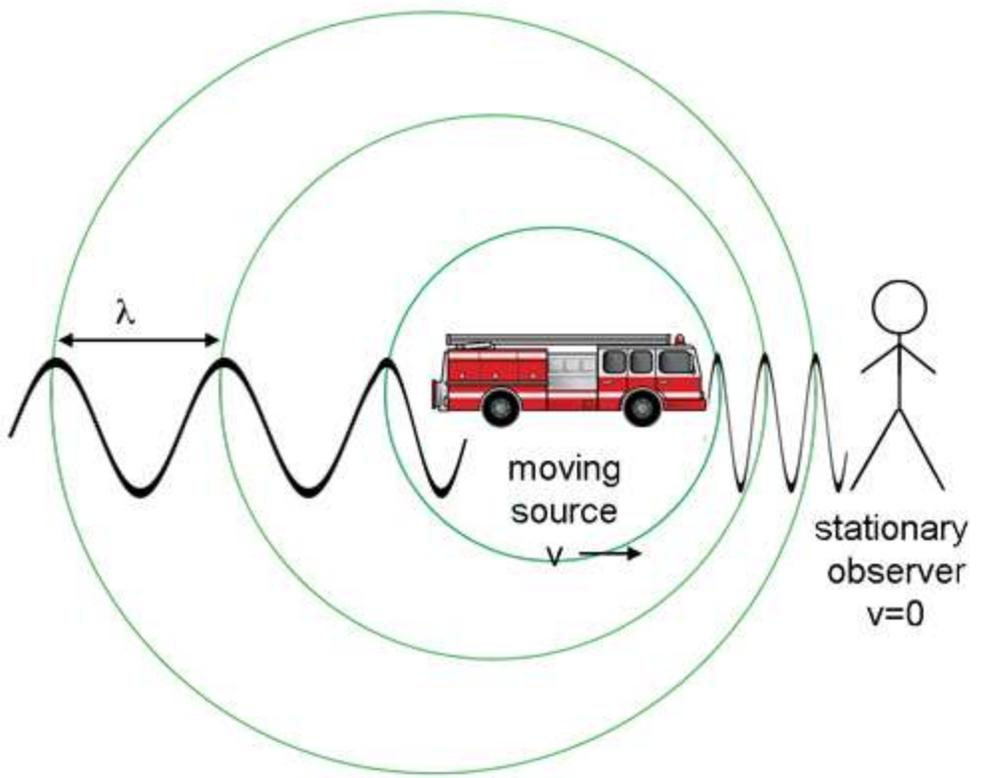
shorter wavelength  
higher frequency  
higher energy

longer wavelength  
lower frequency  
lower energy

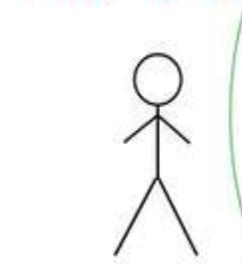


| Color  | Wavelength |
|--------|------------|
| violet | 380–450 nm |
| blue   | 450–495 nm |
| green  | 495–570 nm |
| yellow | 570–590 nm |
| orange | 590–620 nm |
| red    | 620–750 nm |

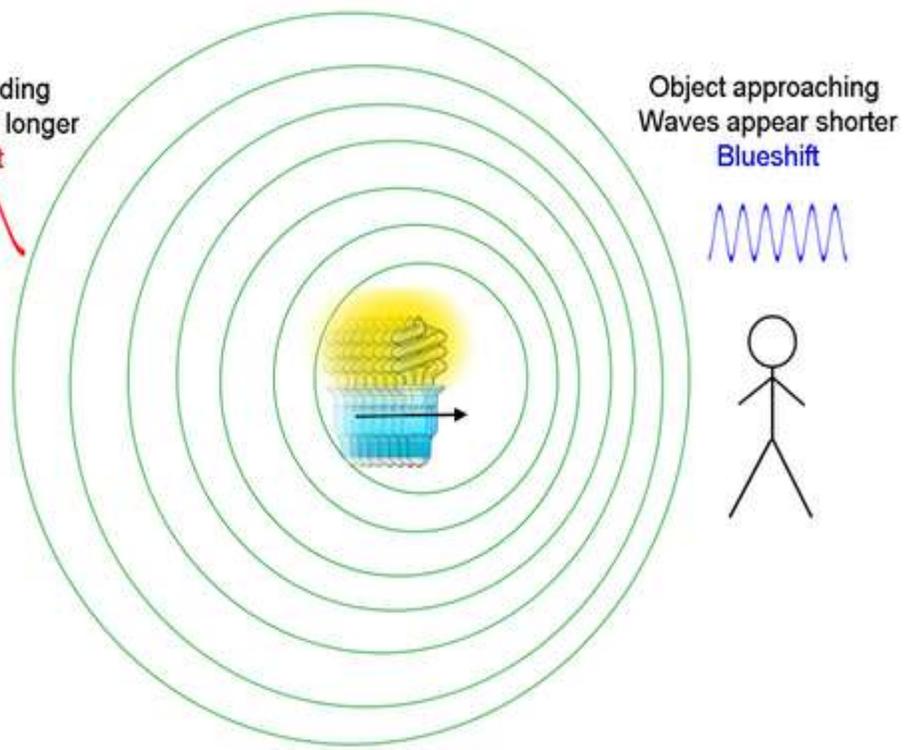
**sleepy Classes**  
enjoying Toppers

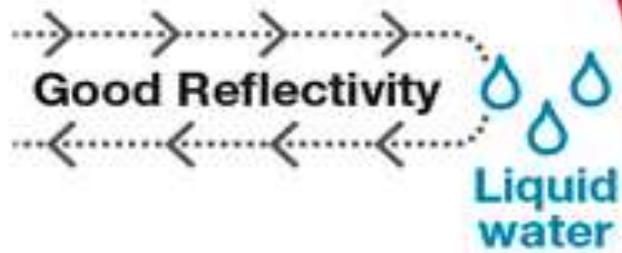
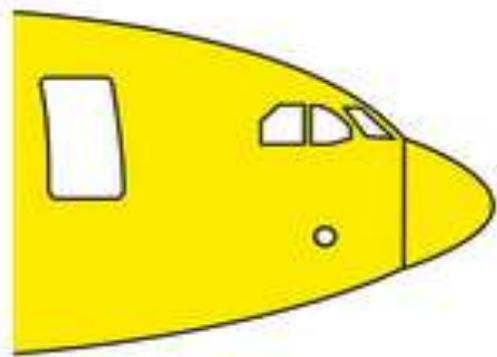


Object receding  
Waves appear longer  
**Redshift**



Object approaching  
Waves appear shorter  
**Blueshift**





**High Reflectivity**



**Wet Hail**

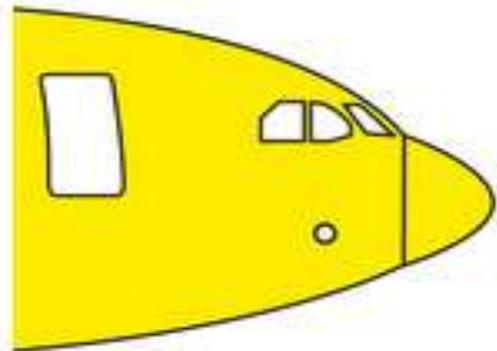
**Rain**

**Wet Snow**

**Dry Hail**

**Dry Snow**

**Drizzle**



**Low Reflectivity**

# EnVision mission

Following NASA's footsteps, the European Space Agency (ESA) announced that it has selected **EnVision as its next orbiter that will visit Venus sometime in the 2030s.**

- Last week, **NASA selected two missions to the planet Venus**, Earth's nearest neighbour.
- The missions **called DAVINCI+ and VERITAS** have been selected based on their potential for scientific value and the feasibility of their development plans

## EnVision

- EnVision is an **ESA led** mission with contributions from NASA.
- It is likely to be launched sometime in the **2030**
- The spacecraft will carry a range of instruments to study the planet's atmosphere and surface, monitor trace gases in the atmosphere and analyse its surface composition. A **radar provided by NASA** will help to image and map the surface.

# EnVision mission

- EnVision will follow another **ESA-led mission to Venus called 'Venus Express'** (2005-2014) that focussed on atmospheric research and pointed to volcanic hotspots on the planet's surface.
- Other than this, **Japan's Akatsuki spacecraft** has also been studying the planet's atmosphere since 2015

**NASA's Discovery Program-** gives scientists a chance to dig deep into their imaginations and find new ways to unlock the mysteries of our solar system. When it began in 1992, the program represented a breakthrough in the way NASA explores space



|               |                                     |   |
|---------------|-------------------------------------|---|
| <b>Active</b> | Lunar reconnaissance orbiter (2009) | LRO is a robotic spacecraft that set out to map the lunar surface   |
|               | InSight (2018)                      | InSight is a Mars lander Interior Exploration using Seismic Investigations, Geodesy and Heat Transport, is exploring the deep interior of Mars  |
| <b>Future</b> | Lucy (Oct 2021)                     | Lucy will visit a main belt <b>asteroid and six Trojan asteroids</b> , a unique family of asteroids that orbit the Sun in front of and behind Jupiter   |
|               | Psyche (2022)                       | The Psyche mission will explore one of the most intriguing targets in the main <b>asteroid belt</b> - a giant metal-rich asteroid, known as 16 Psyche, about three times farther away from the Sun than is the Earth              |
|               | MEGANE (2024)                       | MEGANE spectrometer instrument on the Japanese Aerospace Exploration Agency's <b>Mars Moons eXploration</b> mission is a "mission of opportunity" selected by the Discovery Program   |
|               | DAVINCI+ (2028-30)                  | Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging measure the composition of <b>Venus'</b> atmosphere to understand how it formed and evolved  |
|               | VERITAS (2028-30)                   | The <b>Venus</b> Emissivity, Radio Science, InSAR, Topography, and Spectroscopy, or VERITAS, mission will map Venus' surface to determine the planet's geologic history and understand why it developed so differently than Earth |

# SOFT ROBOTS OR ACTUATORS

- Scientists have developed soft robotic actuators with enhanced photomechanical capacity. It was **developed using porous carbon nanoparticles from waste onion peels**. Soft robots or actuators is the specific subfield of robotics dealing with constructing robots from highly compliant materials similar to those found in living organisms. Soft robotics draws heavily from the way in which living organisms move and adapt to their surroundings.
- In contrast to robots built from rigid materials, soft robots **allow for increased flexibility and adaptability** for accomplishing tasks, as well as improved safety when working around humans. These characteristics allow for the potential use of soft robotics in the fields of medicine and manufacturing.



# DIATOM TEST

- Maharashtra Anti-Terrorism Squad (ATS) relied on a **diatom tests for leads in the alleged murder case of Mansukh Hiran.**
- Diagnosis of death by drowning is difficult in forensic pathology; the mere recovery of a body from a water body does not necessarily imply that the death was due to drowning. This is where the diatom test comes in: it is an important one among a number of tests that have been developed to confirm if the cause of death in such cases was indeed drowning.
- A diatom is a kind of algae found in almost **every aquatic environment, including fresh and marine waters, soils and, in fact, almost anywhere moist.** A diatom test, therefore, entails finding if there are diatoms in the body recovered.

# New Shepard

Recently **Blue Origin** concluded the online auction for the first seat on **New Shepard, a rocket system** meant to take tourists to space

## What is New Shepard

- Named after astronaut Alan Shepard – the first American to go to space – and offers flights to **space over 100 km above the Earth** and accommodation for payloads.
- Essentially, it is a **rocket system** that has been designed to take astronauts and research payloads past the **Karman line** – the **internationally recognized boundary of space**.

## Significance

- The idea is to provide **easier and more cost-effective access to space** meant for purposes such as **academic research, corporate technology development** and entrepreneurial ventures among others.
- It will also allow space tourists to experience **microgravity** by taking them 100 km above the Earth.

# New Shephard

- Space tourism seeks to give lay people the **ability to go to space for recreational, leisure or business purposes**.
- The idea is to make space more **accessible to those individuals** who are not astronauts and want to go to space for non-scientific purposes.

## Past

- The **first space tourist** was **US millionaire Dennis Tito**, who in 2001 paid USD 20 million to hitch a ride on a **Russian Soyuz spacecraft** to **visit the international space station** and spent eight days there
- In 2004, test pilot **Mike Melville** became the **first private astronaut to fly beyond the Karman Line**.

**KARMAN LINE** 100 KM

**CAPSULE FREE FLIGHT**

**SEPARATION**

**DRAG BRAKES DEPLOY  
ENGINE RELIGHTS**

**NEW SHEPARD LIFTOFF**

**BOOSTER LANDING**

**CAPSULE LANDING**

**WEST TEXAS LAUNCH SITE** 3,700 FT ABOVE MSL

# Xenobots

- According to a recent study, Xenobots has become world's first living robots **which can reproduce**.
- Xenobots are **made up of a collection of frog egg cells** instead of metals or plastics that can function as one tiny unit.
- The reason scientists classify them as robots is that they are **designed and engineered to behave in very specific ways**.
- They are engineered inside of a petri dish and can be programmed to move.
- The xenobot, which is a millimeter wide, has been described as a "reconfigurable creature". The xenobots were first designed in 2020 on a supercomputer at the University of Vermont and then assembled and tested by biologists at Tufts University in Massachusetts.

# Xenobots

- The xenobots “can move toward a target, perhaps pick up a payload (like a medicine that needs to be carried to a specific place inside a patient) – and heal themselves after being cut

# Zero-Shot Learning (ZSL)

- Machines have become much **more intelligent**, but **without a properly labelled training data set of seen classes**, they cannot distinguish between two similar objects.
- On the other hand, humans are capable of identifying approximately 30,000 basic object categories.
- In machine learning, this is considered as the problem of **Zero-shot learning (ZSL)**.
- ZSL is a problem setup in machine learning, where at **testing**, a **learner observes samples from classes that were not observed while training the model** and predicts the category they belong to Zero-shot methods.
- It basically works by **combining the observed/seen and non-observed/unseen categories** through some types of auxiliary information, which encodes observable distinguishing properties of objects. The auxiliary information may include attributes, textual descriptions, etc.

## Zero-Shot Learning

### Step 1

**Training:**  
Where the knowledge about the attributes is captured

### Step 2

**Inference:**  
The knowledge is then used to categories instances among a new set of classes.

# Air-Independent Propulsion Technology

- In a recent announcement, France's Naval Group stated that it will not be bidding on the P-75I Project since it does not yet use AIP (Air-Independent Propulsion) Technology.

## About AIP Technology

- AIP technology has been created or is in the process of being developed in approximately ten countries, and approximately twenty countries have AIP submarines.
- AIP is a technology for **conventional non-nuclear submarines that is currently in development.**

# Air-Independent Propulsion Technology

- Submarines are broadly classified into two categories: conventional and nuclear.
  - **Conventional submarines** are powered by diesel-electric engines, which need their surfacing on a nearly daily basis in order to get air oxygen for fuel burning. If the submarine is equipped with an AIP system, it will **only be required to take in oxygen once a week.**
- DRDO (Defence Research and Development Organization) considers the **indigenously developed AIP**, which is one of the key missions of the Naval Materials Research Laboratory (NMRL - DRDO), to be one of the most ambitious projects undertaken by the DRDO (Defence Research and Development Organization) for the Indian Navy.

# Air-Independent Propulsion Technology

- **AIP system based on a fuel cell:** If an AIP is powered by a fuel cell, the energy is produced by mixing hydrogen and oxygen, with only water being produced by the fuel cell as waste product, reducing the amount of marine pollution. The cells are very efficient and **do not have any moving elements, resulting in a low acoustic emission of sound from the submarine.**

# Air-Independent Propulsion Technology

## Advantages

- AIP has a force multiplier impact on the lethality of a diesel-electric submarine since it **increases the boat's submerged endurance** by a factor of several hundred times.
- When compared to other technologies, the performance of a **fuel cell-based AIP is superior.**
- The use of AIP technology allows a conventional submarine to remain submerged for far longer periods of time than normal diesel-electric submarines do.
- In order to run their generators, which recharge the batteries that allow the submarine to function underwater, all conventional submarines must surface periodically. However, the more frequently a submarine appears, the greater the likelihood that it will be discovered. **AIP allows a submarine to remain below for more than a fortnight, but diesel-electric vessels can only stay submerged for two to three days.**

# Air-Independent Propulsion Technology

## Disadvantages

- As a result of installing AIP, the **length and weight of the boats are increased**, as is the need for **pressurised liquid oxygen (LOX)** storage on-board and power for all three technologies.

# Submarines

## Conventional submarines

- Use a diesel-electric engine, and must surface daily for oxygen for fuel combustion.

## Advantage

- Smaller - easier to maneuver in shallow waters and harder to detect
- Ease and quietness of operation



# Submarines

## Conventional submarines

### Disadvantage

- Diesel-electric submarines require to come to the surface frequently **to charge their batteries, their underwater endurance time is less**
- **Risk of detection** by enemy radar

# Submarines

## Air Independent Propulsion (AIP)

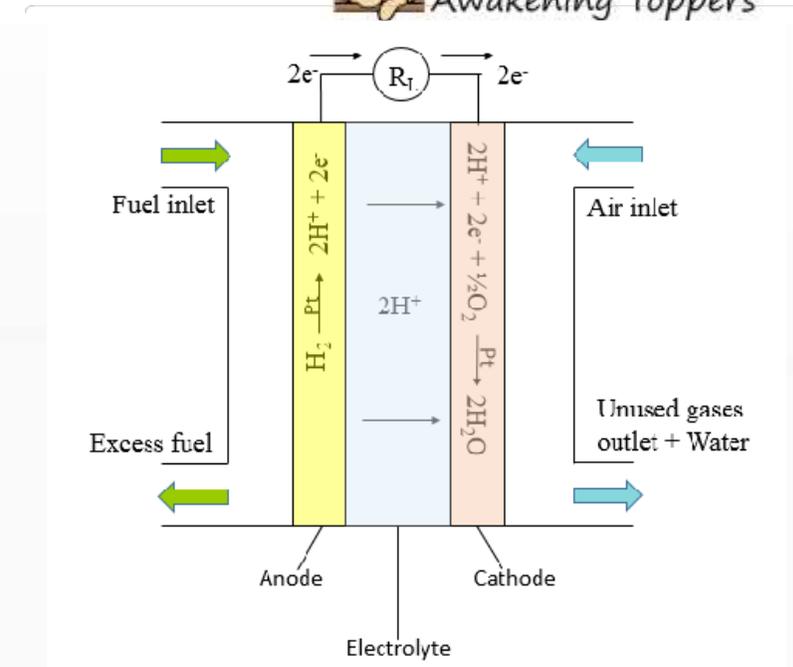
- Technology which allows a non-nuclear submarine to operate without the need to access atmospheric oxygen

# Submarines

## Air Independent Propulsion (AIP)

### Fuel cell AIP

- An electrolytic fuel cell releases energy by combining hydrogen and oxygen, with only water as the waste product.
- The cells are highly efficient, and do not have moving parts, thus ensuring that the submarine has a low acoustic signature



# Submarines

## Basics

### Electrolysis

- When each water molecule **splits into its components**: two parts hydrogen and one part oxygen. That process is called **electrolysis**.
- **Fuel cell (Reverse electrolysis)**
- What takes place inside a fuel cell is electrolysis in reverse: **Combine hydrogen and oxygen, and you get water and electricity**

# Submarines

## Air Independent Propulsion (AIP)

- Fuel cell technology-based AIP generates power through the **reverse electrolysis of oxygen and hydrogen**. In this process, the two elements chemically combine, thereby generating electricity to charge the submarine's batteries. This process **does not need air, but requires storage of highly inflammable hydrogen on board**

# Submarines

DRDO's AIP

## Innovative Phosphoric Acid Fuel Cell technology

- This process is more tolerant of fuel impurities, **offers longer life and efficiency**, and is much safer, since it does not require hazardous Hydrogen to be stored on board.

# Submarines

- The DRDO's AIP system, once ready, will from 2024-25 onward, be “retrofitted” into six **Scorpene submarines that are being built in India under Project 75**
- As per various reports the **six Project-75I submarines will be powered by AIP systems that the foreign vendor**

# Submarines

## Nuclear Submarine

- Not required to be refueled and brought to the surface again
- **Disadvantage**
- The reactor needs to be cooled even when the submarine is not moving
- The nuclear fission generates enormous amounts of the harmful radiation that if it is leaked , It can damage both the human and the marine life.

# Indrajaal

- It is an **autonomous defence weapon system** that uses technologies such as **Artificial Intelligence, cybersecurity and robotics** to identify and counter threats.
- It is capable of protecting a large area of **1,000-2,000 sq km per system** against threats such as **Unmanned Aerial Vehicles (UAVs), incoming weapons (missiles), loitering munitions and Low-Radar Cross Section (low flying) targets.**
- Indrajaal, developed by **Hyderabad-based Grene Robotics company**, came in the backdrop of possible use of drones in recent attack in J&K.

# Indrajaal

- Grene Robotics has designed and developed **India's first 100% indigenous** Unified, Distributed and wide-area Autonomous Drone Defence Dome called Indrajaal.
- Indrajaal will protect a large area of 1000-2000 sq. km per system against threats such as UAV's, Incoming Weapons etc

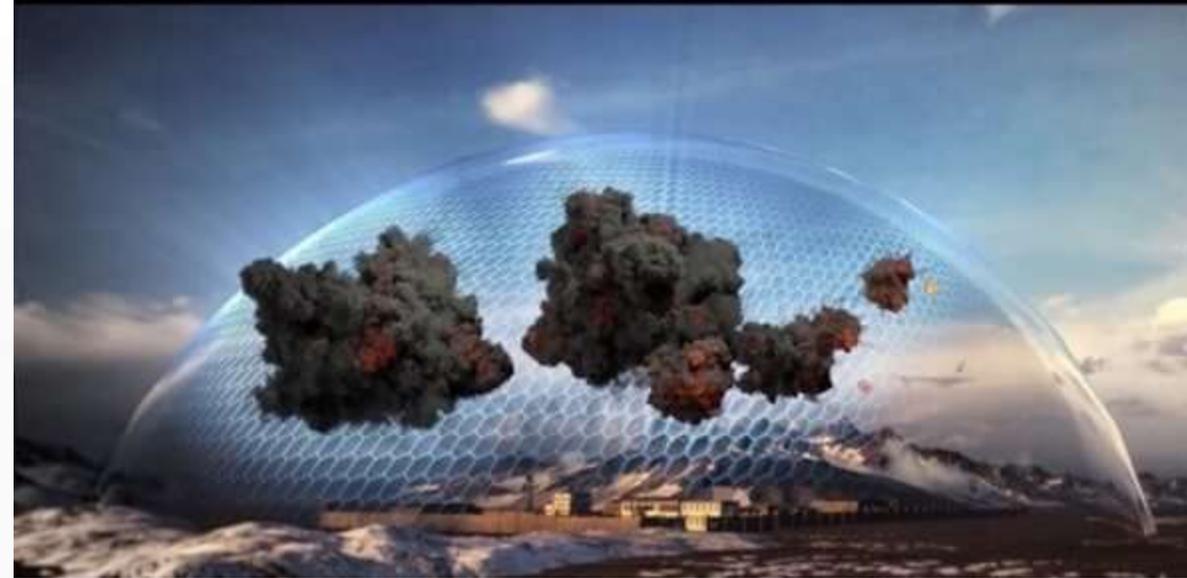
## How does Indrajaal work

- **It is** a combination of 9-10 modern technologies powered by Artificial Intelligence, Cybersecurity, and Robotics that is **capable of identifying, assessing, deciding, acting and evolving autonomously in real-time.**

# Indrajaal

1. Real-time situational awareness
2. Distributed, Decentralised, and Mobile
3. Integrated and Intelligent meshed network
4. Ability to integrate with all current weapons suite and infrastructure
5. Honeycombed cell structure seamlessly built over a combination of 9-10 technologies
6. 24x7x365 persistent and autonomous monitoring, tracking, and action

## AUTONOMOUS DRONE DÉFENSE DOME SYSTEM: "INDRAJAL"



# Nano sniffer

The Indian Institute of Technology (IIT)-Bombay incubated startup NanoSniff Technologies has developed the **world's first micro-sensor based explosive trace detector (ETD)**

- To be branded and marketed as 'NanoSniffer', the device has been developed for the **first time in the world using a micro-electromechanical system (MEMS)**, with its **core technology being protected by patents in the US, Europe and India**

# Nano sniffer

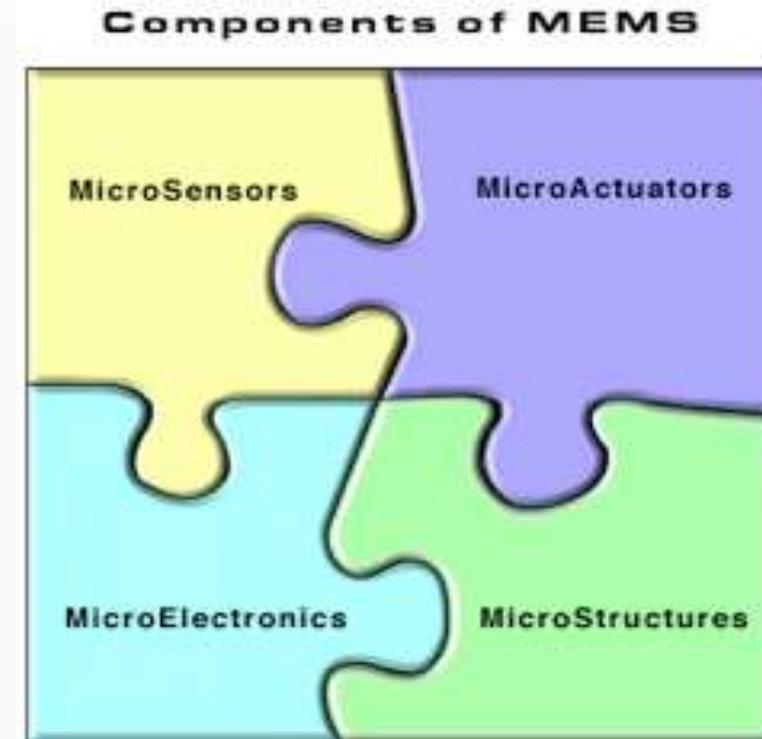
## NanoSniffer

- **100% 'Made in India' product** in terms of research, development & manufacturing.
- NanoSniffer provides trace **detection of nano-gram quantities of explosives** and can **accurately detect a wide range of military, commercial and homemade explosives** threats
- Further analysis of the algorithms **also helps in categorization of explosives** into the appropriate class.
- It can **detect explosives in less than 10 seconds**

# Nano sniffer

## Micro-Electro-Mechanical Systems, or MEMS

- is a technology that in its most general form can be defined as **miniaturized mechanical and electro-mechanical elements** (i.e., devices and structures) that are made using the techniques of microfabrication.



# Nano sniffer

- **Microsensors and microactuators** are appropriately categorized as “transducers”, which are defined as devices that convert energy from one form to another.
- In the case of **microsensors, the device typically converts a measured mechanical signal into an electrical signal**

# Doubts over defence supplies to India

With tensions escalating between Russia and the West over the Ukraine crisis, India, which has major defence cooperation with Moscow and Kyiv, faces uncertainty over timely deliveries in the near future in addition to the lingering threat of the U.S. sanctions under CAATSA (Countering America's Adversaries Through Sanctions Act) over the S-400 deal

# Doubts over defence supplies to India

## What is CAATSA?

- Enacted in 2017, it is a US federal law that imposed sanctions on **Iran, North Korea and Russia**.
- Includes sanctions against countries that engage in significant transactions with Russia's defence and intelligence sectors.
- The Act empowers the US President to impose at least five of the 12 listed sanctions on persons engaged in a “significant transaction” with Russian defence and intelligence sectors

# Doubts over defence supplies to India

## S-400 Triumf Missile System:

- The S-400 Triumf is a mobile, **surface-to-air missile system (SAM)** designed by Russia.
- It is the most dangerous operationally deployed modern long-range SAM (MLR SAM) in the world, considered much **ahead of the US-developed Terminal High Altitude Area Defense system (THAAD)**.
- The system can **engage all types of aerial targets** including aircraft, unmanned aerial vehicles (UAV) and ballistic and cruise missiles within the **range of 400km, at an altitude of up to 30km**.
- The system can **track 100 airborne targets** and engage six of them simultaneously
- **Maximum target speed: 4.8 km/s** (17,000 km/h; 11,000 mph; Mach 14)

# Doubts over defence supplies to India

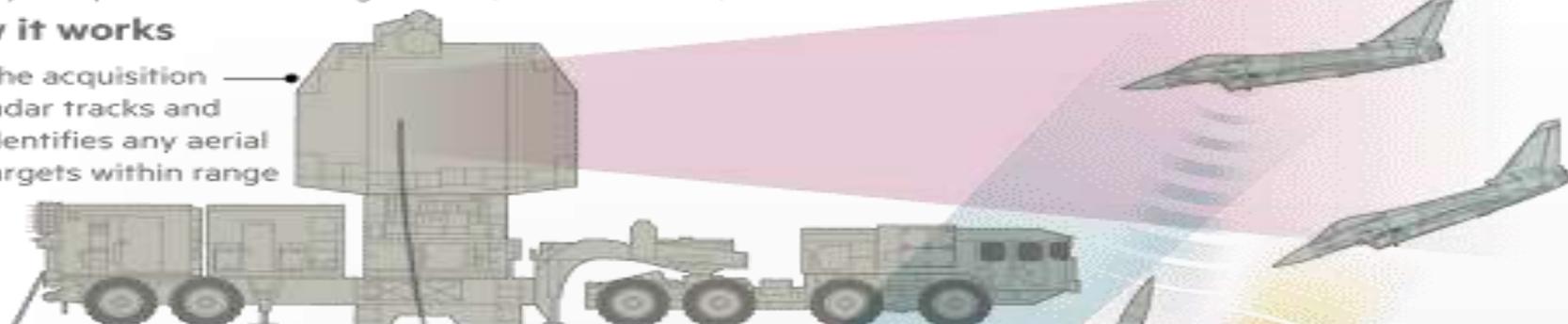
- Target detection distance: 600 km
- The system comes equipped with **four types of missiles**:
  1. short- range up to 40 km;
  2. medium-range up to 120 km;
  3. long-range 48N6 going as far as 250 km, and
  4. very-long-range 40N6E up to 400 km and a flight altitude of 180 km.
  5. It can **simultaneously track up to 160 objects in a 600 km range**, and target 72 objects in a 400 km range, according to a study.

# The S-400 mobile surface-to-air missile system

Turkey has purchased two regiments (four battalions)

## How it works

**1** The acquisition radar tracks and identifies any aerial targets within range



**2** The targets' details are passed to the command post.

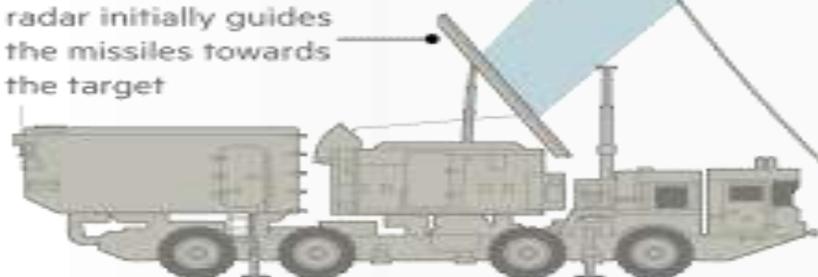
Acquisition radar  
Crew of four. Can track 300 targets

**3** The command post crew, select the optimum missile type and launch vehicle in the best position and order the launch



Command post  
Crew of five

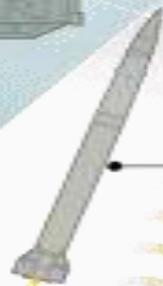
**4** The engagement radar initially guides the missiles towards the target



Engagement radar  
Can control 12 missiles on six targets

**5** If the missile has semi-active homing (its own radar receiver), it can hit the target based on radar reflections from the engagement radar

**6** If the missile has active homing (its own radar transmitter and receiver), it can hit the target using its own radar

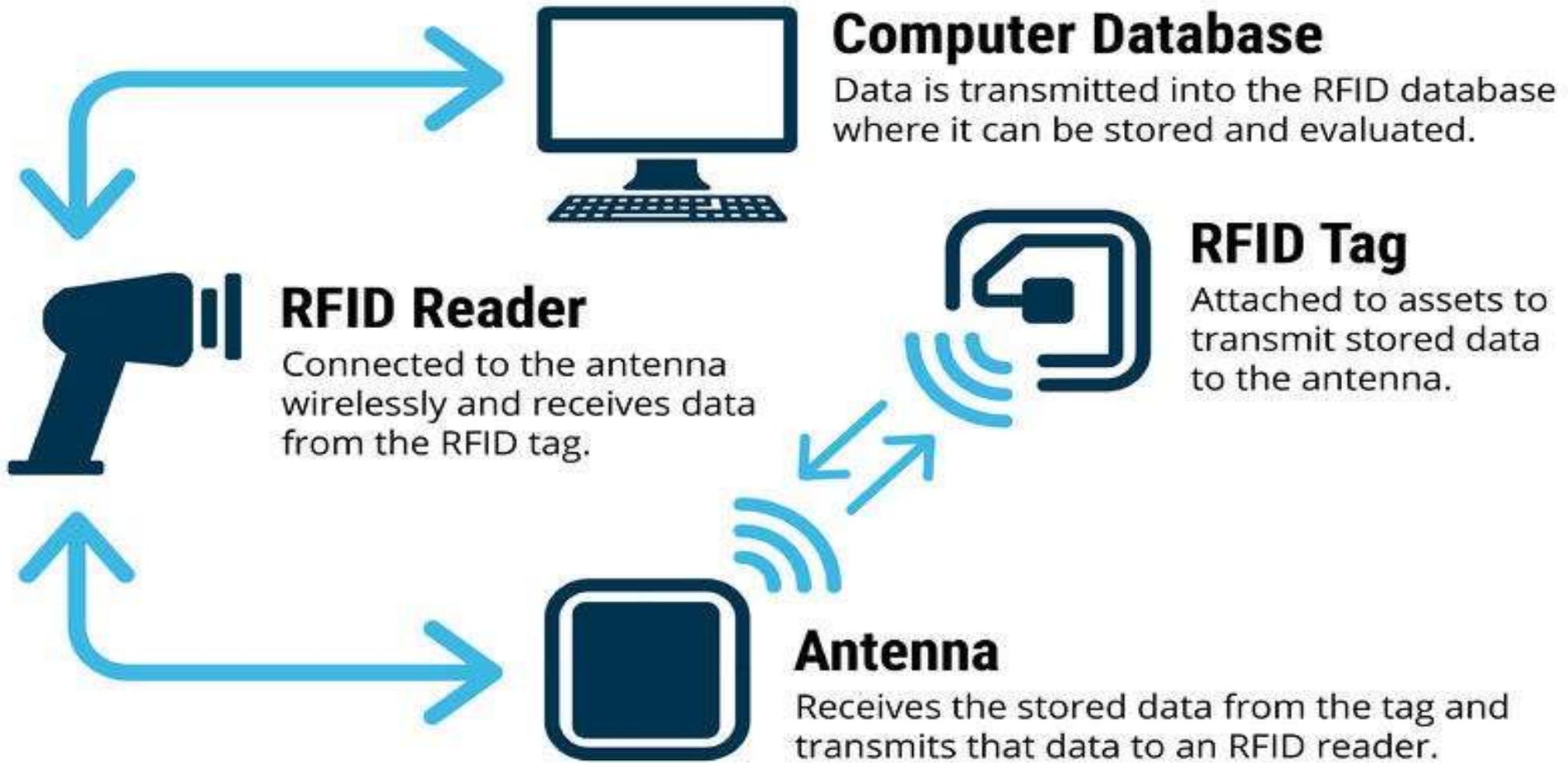


Launch vehicle  
Up to 16 per regiment. Each has four launch tubes

# RFID

- Indian Army has commenced implementation of RFID tagging of its ammunition inventory.

# Basic RFID System



## Low-Frequency Tags (LF)

- The primary frequency range of 125kHz – 134kHz
- Can read a span of a **few inches**
- Lowest data transfer rate among all the RFID frequencies
- Store a small amount of data
- Asset Tracking, and Healthcare

## High-Frequency Tags (HF) - Most widely used around the world

- The primary frequency range of 13.56MHz
- Read range: 30 cm
- The capability of reading multiple tags simultaneously
- Can store up to 4k of data
- Easily read while attached to objects containing water, tissues, metal, wood, and liquids.

HF Applications – Library Books, Personal ID Cards, Airline Baggage, and Credit Cards

## **UHF Passive Tags - use energy from the RFID reader**

- The primary frequency range: 860MHz – 960MHz
- Read Range: **25 meters**
- High data transmission rate
- Wide variety of tag sizes
- UHF Passive Tag Applications – Supply Chain Tracking, Manufacturing, Pharmaceuticals and **Electronic Tolling**

## **UHF Active Tags - battery operated**

- The primary frequency range: 433MHz
- Read Range: **30 - 100+ meters**
- Large memory capacity
- High data transfer rate
- UHF Active Tag Applications – Vehicle Tracking, Auto Manufacturing, and Construction

# Non fungible tokens (NFTs)

- Anything that can be **converted into a digital form can be an NFT.**
- Everything from your **drawings, photos, videos, GIF, music, in-game items, selfies, and even a tweet** can be turned into an NFT, which can then be **traded online using cryptocurrency.**
- But what makes NFTs unique from other digital forms is that it is **backed by Blockchain technology.**
- For the uninitiated, Blockchain is a distributed ledger where all transactions are recorded.
- It is **like your bank passbook**, except all your transactions are transparent and can be **seen by anyone and cannot be changed or modified once recorded.**



# Non fungible tokens (NFTs)

## How do NFTs work?

- NFT works on blockchain as it gives users **complete ownership of a digital asset.**
- For instance, **if you're a sketch artist, and if you convert your digital asset to an NFT**, what you get is proof of ownership, powered by Blockchain.

# Non fungible tokens (NFTs)

**How is an NFT different from cryptocurrency?**

- **NFTs and cryptocurrencies are very different** from each other. While both are built on Blockchain, that is where the similarity ends.
- **Cryptocurrency is a currency and is fungible**, meaning that it is interchangeable. For instance, if you hold one crypto token, say one Ethereum, the next Ethereum that you hold will also be of the same value.
- **But NFTs are non-fungible, that means the value of one NFT is not equal to another.** Every art is different from other, making it non fungible, and unique.

# Facial recognition technology

Facial recognition used to verify job beneficiaries: govt.

- **Facial recognition authentication** is used as one of the methods for Aadhaar authentication for online verification of beneficiary prior to **COVID-19 vaccination** wherein facial template is captured and sent to UIDAI for verification of image of beneficiary

## Issues

- Even though the Ministry of Health and Family Welfare (MoHFW) admitted in a recent RTI query response to the use of facial recognition technology (FRT) for online verification of beneficiaries at vaccination centres, it **failed to provide any legislative or legal order that authorised the use of such technology.**
- **No privacy impact assessment** of the use of FRT was conducted prior to its deployment

# Facial recognition technology

- Use of FRT for verification of the beneficiaries' data would be according to the terms furnished in the '**Verifier & Vaccinator Module User Manual**' included in the CoWin portal.
- However, the **manual was not available on the CoWin portal** or any open source webpage
- Government was also **unable to provide any information** related to the accuracy of the FRT used

# Facial recognition technology

## Facial recognition technology

- Facial recognition is a way of identifying or confirming an individual's identity using their face.
- Facial recognition systems can be used to identify people in photos, videos, or in real-time
- Facial recognition is a category of biometric security

# Facial recognition technology

Face  
detection

Face  
Analysis

Data  
Formation

Match  
Finding

# Facial recognition technology

## Past News

### Automated Facial Recognition System (AFRS)

- **Mobile and web application hosted in NCRB's** (which manages data for police) data centre in Delhi but used by all police stations in the country.
- It works by **comparing the new image of an unidentified person often taken from CCTV footage with the existing database** (AFRS maintains a database with photos and videos of peoples faces) to find a match and identify the person.

# Facial recognition technology

## Integration of AFRS

- **Crime and Criminal Tracking Network & Systems (CCTNS):** managed by NCRB
- **Integrated Criminal Justice System (ICJS)**
- **Khoya Paya Portal**-citizen based website to exchange information on missing and found children developed by the **Ministry of Women and Child Development** and the **Department of Electronics and Information Technology (DeitY)**.

# Facial recognition technology

## FRS in airports

- Facial recognition systems have been made active at several major Indian airports, including Delhi airport, installed under [DigiYatra Initiative](#).

## FRP in election

- **Telangana's Election Commission** recently piloted a facial recognition app in its civic elections to address the issue of voter impersonation.

# Asteroids

- Asteroids are small, rocky objects that orbit the sun.
- Although **asteroids orbit the sun like planets, they are much smaller than planets.**
- They are made up of **metals and rocks.**
- They tend to have **shorter and elliptical orbits.**
- They **do not produce a coma or tail atmosphere.**
- **Main Asteroid Belt:** The majority of known asteroids orbit within the asteroid belt between **Mars and Jupiter.**

# Asteroid Apophis

The USA's NASA space agency **has ruled out the possibility** of the dreaded **asteroid Apophis** causing any damage to the Earth for the next 100 years

- The “**risk list**” refers to the **Sentry Impact Risk Table** maintained by CNEOS, which includes all the asteroids with orbits close to Earth.
- **Apophis is categorised as a PHA**

## What are asteroids?

- Asteroids are rocky objects that orbit the Sun, much smaller than planets. They are also called minor planets.
- According to **NASA, 994,383 is the count of known asteroids**, the remnants from the formation of the solar system over 4.6 billion years ago.

# Asteroid Apophis

**Asteroids are divided into three classes.**

## **First**

- those found in the main **asteroid belt between Mars and Jupiter**, which is estimated to contain somewhere between 1.1-1.9 million asteroids.

## **Second**

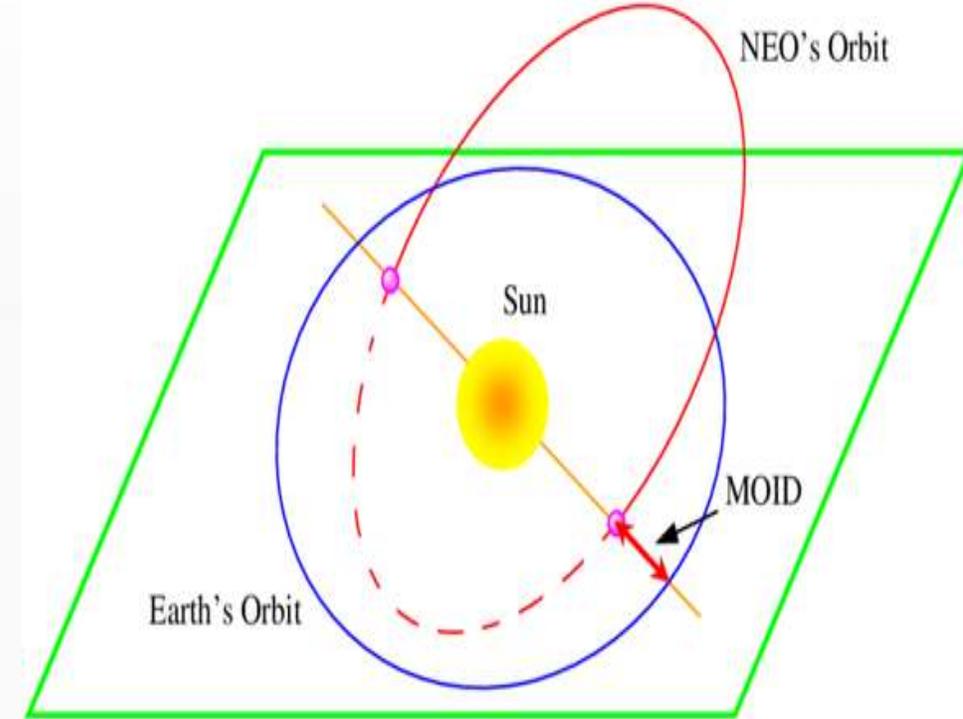
- **Trojans**, which are asteroids that **share an orbit with a larger planet**. NASA reports the presence of **Jupiter, Neptune and Mars trojans**. In 2011, they reported an Earth trojan as well.

## **Third**

- **Near-Earth Asteroids (NEA)**, which have orbits that pass close by the Earth. Those that cross the Earth's orbit are called **Earth-crossers**.
- More than 10,000 such asteroids are known, out of which over 1,400 are classified as **potentially hazardous asteroids (PHAs)**.

## Potentially Hazardous Asteroids (PHAs)

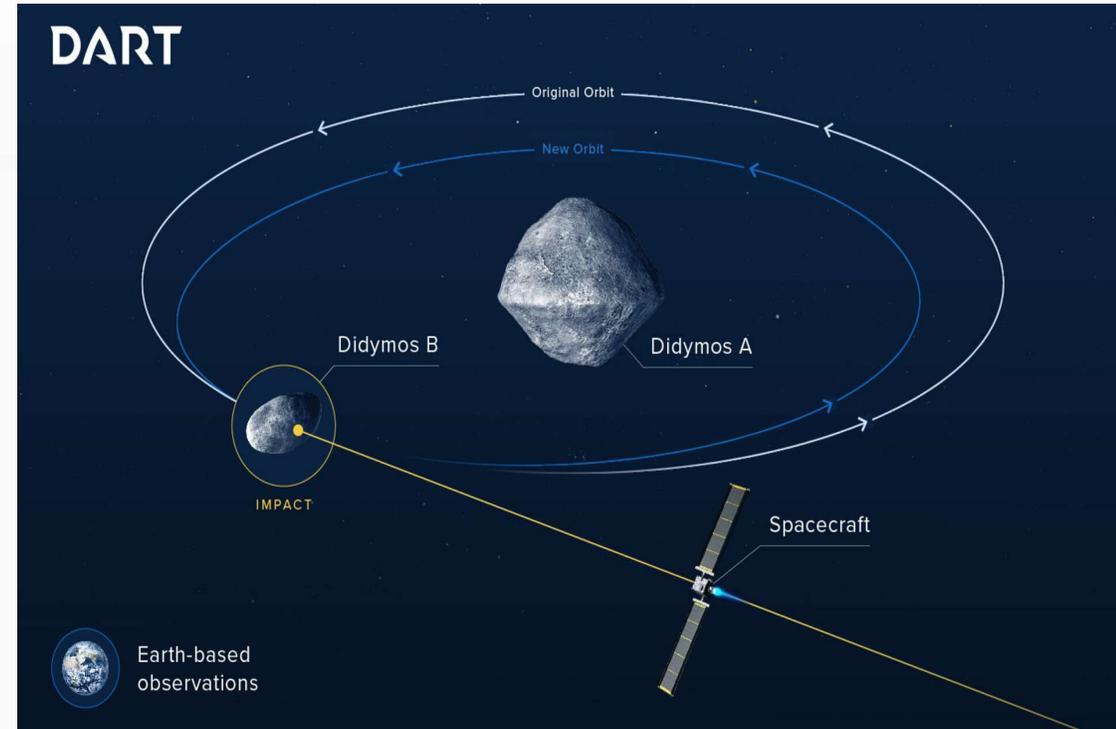
- ❑ All asteroids with a minimum orbit intersection distance (**MOID**) of **0.05 au or less** and an absolute magnitude (H) of 22.0 or less are considered PHAs.
- **Minimum Orbit Intersection Distance** is a method **for calculating the minimum distance between two almost overlapping elliptical orbits**
- An asteroids that can't get any closer to the Earth (i.e. **MOID**) than 0.05 au (roughly 7,480,000 km or 4,650,000 mi) or are **smaller than about 150 m (500 ft) in diameter** (i.e. H = 22.0 with assumed albedo of 13%) are **not considered PHAs**



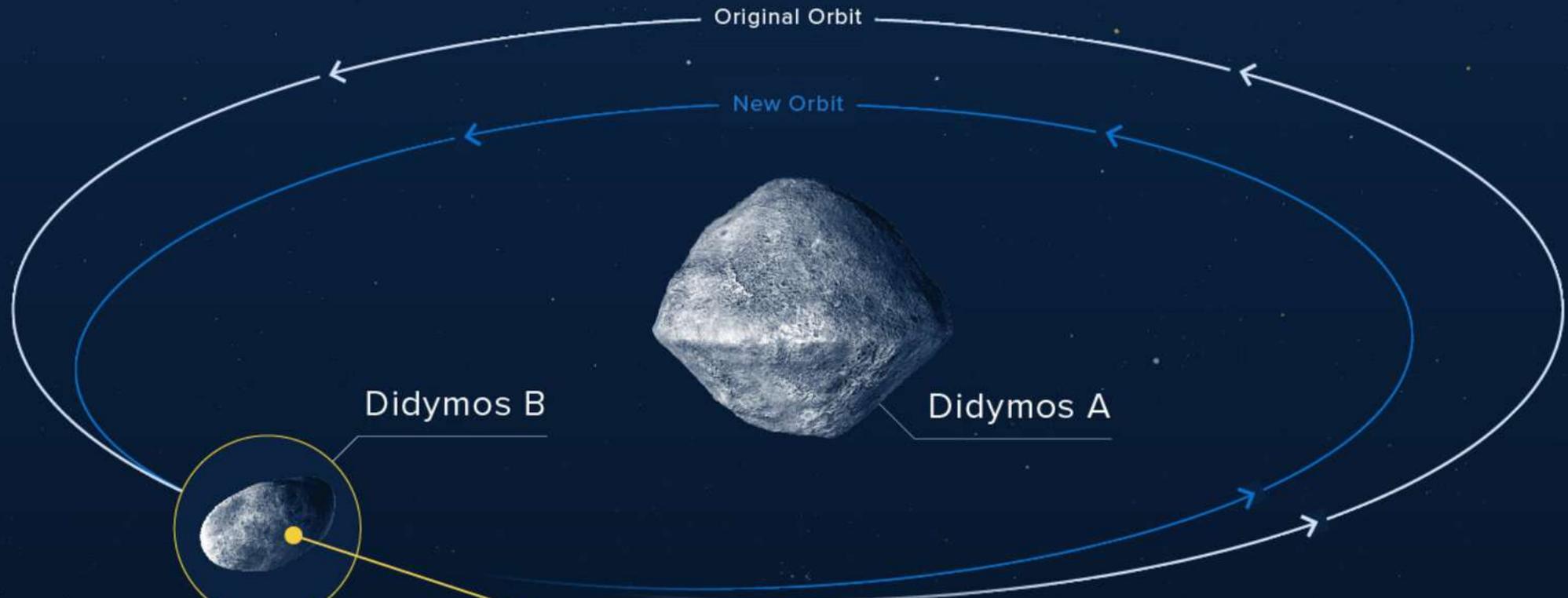
# Asteroid Impact Deflection Assessment (AIDA)

## Method of Planetary defence

- ❑ **Blowing up** the asteroid before it reaches Earth,
- ❑ **Deflecting** it off its Earth-bound course by hitting it with a spacecraft (**AIDA**)



# DART



Didymos B

Didymos A

IMPACT

Spacecraft



Earth-based observations

# Asteroid Impact Deflection Assessment (AIDA)

NASA has launched its first planetary defense test mission named the Double Asteroid Redirection Test (DART).

- Joint mission of **NASA & ESA**
- Deflect the orbit of the smaller body through an **impact by one spacecraft.**
- NASA is building the **Double Asteroid Impact Test (DART)** spacecraft for this

# Asteroid Impact Deflection Assessment (AIDA)

- ESA's contribution is a mission called **Hera**, which will perform a close-up survey of the **post-impact asteroid**
- Flying along with **DART** will be an **Italian-made** miniature CubeSat, called **LICIACube (Nanosatellite)**, to record the **moment of impact**.

# Asteroid Impact Deflection Assessment (AIDA)

□ NASA has launched its first planetary defense test mission named the Double Asteroid Redirection Test (DART).

## About DART Mission:

- DART is a low-cost spacecraft.
- It also carries about 10 kg of xenon which will be used to demonstrate the agency's new thrusters called NASA Evolutionary Xenon Thruster-Commercial (NEXT-C) in space.

# Double Asteroid Redirection Test (DART) Mission: NASA

- The spacecraft carries a **high-resolution imager** called **Didymos Reconnaissance and Asteroid Camera for Optical Navigation (DRACO)**. Images from DRACO will be sent to Earth in real-time and will help study the impact site and surface of Dimorphos.

## Hayabusa-JAXA

- Sample return mission
- Near earth asteroid-Itokawa
- Launch-2003---return 2010
- First asteroid sample return

## Hayabusa-2

- 2014
- Ryugu** asteroid (C-type)
- Return-2020

- Organic matter+ water

## OSIRIS-Rex-NASA

- Launch-2016
- Return-2023
- Bennu**(C-type)

## What are asteroids made of

- C-type-Carbonaceous material
- 75% of total
- Mostly water & hardly any metallic element
- S-type-Silicate material
- 17% of total asteroids
- Fe,Nickel,Mg
- Hardly any water but little brighter than C type
- M-type-Metal
- Platinum
- Large amount of platinum on earth come from this asteroid

# Khagolshala Asteroid Search Campaign 2021

Recently Jawahar Navodaya Vidyalaya students detect asteroids under the Khagolshala Asteroid Search Campaign 2021

- **Eight asteroids detected by sixteen students** of Jawahar Navodaya Vidyalayas, under the Khagolshala Asteroid Search Campaign 2021 were conferred the “**Provisional Status**” by the **International Astronomical Search Collaboration**

# Khagolshala Asteroid Search Campaign 2021

## Khagolshala Asteroid Search Campaign 2021

- The campaign is an initiative of the **Office of Principal Scientific Adviser, Government of India, and SPACE Foundation.**
- It is the **India chapter of an international student research program** that has got students involved in the search for asteroids.
- **High-quality astronomical data sets are distributed** to students for analysis and identification of asteroids.
- **Students analyze the data using software** which then leads to potential discoveries.
- These observations **feed into the Near-Earth Object (NEO) data being compiled by NASA** and the Jet Propulsion Lab (JPL).

# Khagolshala Asteroid Search Campaign 2021

- **Space India** has established Khagolshala Astronomy and Space Education Labs (ASELs) across 20 Jawahar Navodaya Vidyalayas to date.
- **Space India** is working with a vision to get the younger generation in the country engrossed in astronomy and space sciences; application, exploration, innovation, and research in these areas.
- The team at Space India works by **engaging students through experimentation, observation, and analysis** of the universe.

# Khagolshala Asteroid Search Campaign 2021

- Students get access to the **real-time data** from the 'PANSTARRS' (The Panoramic Survey Telescope and Rapid Response System Telescope), located in Hawaii.

## **SPACE Foundation**

- Established in 2001, to **popularize science** and inculcate scientific temperament among the masses especially students in India.
- SPACE is working to create citizen scientists through various programs on science and astronomy education, and innovation in India.
- These programs have the larger goal of fostering **scientific temperament in society, especially among the youth.**

# Naming of an Asteroid

## Preliminary detection

- The first, original observation of a new asteroid

## Provisional status

- The asteroid must be observed a second time within the next 7-10 day
- If it is, then the detection is changed to provisional status by the Minor Planet Centre (MPC).

## Cataloguing an asteroid

- Provisional status are maintained in the MPC database for many years until there have been a sufficient number of observations to fully determine the orbit.
- This process typically takes 6-10 years, at which point the asteroid is numbered and catalogued by the International Astronomical Union.

## Naming an asteroid

- Numbered asteroids can be named by their citizen scientist discoverers

# Asteroid 16 Psyche

A recent study at National Aeronautics and Space Administration (NASA) has found out that asteroid 16 Psyche, **which orbits between Mars and Jupiter, could be made entirely of metal** and is worth an estimated 10,000 quadrillion US dollars.

- **Unlike most asteroids** that are made up of rocks or ice, scientists believe that Psyche is a **dense and largely metallic object** thought to be the core of an earlier planet that failed formation.
- Psyche's shape is like a potato which **takes about five earth years to complete one orbit of the sun** but only **a bit over 4 hours to rotate** once on its axis
- Images from NASA's Hubble Space Telescope has shown that the surface may mostly comprise iron and nickel, similar to the Earth's core.

# NASA's New Spacecraft: Near-Earth

## Asteroid Scout

### Context

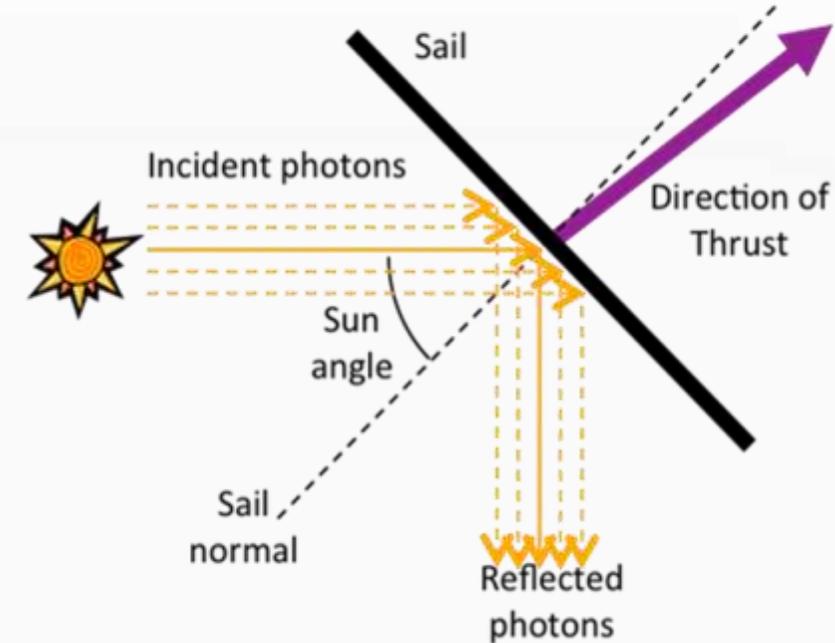
Recently, National Aeronautics and Space Administration (NASA) has announced that its **new spacecraft, named Near-Earth Asteroid Scout or NEA Scout, has completed all required tests** and has been safely tucked inside the Space Launch System (SLS) rocket.

### About NEA Scout

- Near-Earth Asteroid Scout, or NEA Scout, is a miniaturized spacecraft, known as a **CubeSat, developed under NASA's Advanced Exploration Systems Program.**
- The NEA Scout will **serve as a robotic reconnaissance mission to fly by and return data from an asteroid representative of near-Earth asteroids that may one day be human destinations.**

# NASA's New Spacecraft: Near-Earth Asteroid Scout

- It will also be **America's first interplanetary mission using a special solar sail propulsion.**
- It is one of several payloads that will hitch a ride on Artemis I, which is expected to be launched in November, 2021.
- **NEA Scout launches to the Moon in 2021** with a fleet of other small satellites aboard Artemis 1.



# NASA's New Spacecraft: Near-Earth Asteroid Scout

## What are CubeSats?

- **CubeSats are miniaturized spacecraft** with great potential for space-based science, exploration, engineering support, Earth observation, and relay communication.
- In addition to their efficiency, low cost and compatibility with larger payloads, CubeSats also offer opportunities for increased science return and operational support of larger missions.

# NASA's New Spacecraft: Near-Earth

## Asteroid Scout

### Near-Earth Objects (NEOs):

- NEOs are **comets and asteroids** pushed by the gravitational attraction of nearby planets into orbits which allow them to enter the Earth's neighbourhood.
- These objects are **composed mostly of water ice with embedded dust particles.**
- NEOs occasionally approach close to the **Earth as they orbit the Sun.**

# Lucy: The First Mission to the Trojan Asteroids

## Context

National Aeronautics and Space Administration (NASA) is set to launch 'Lucy', its first mission to explore the Jupiter Trojan Asteroids.

## Mission Lucy

- It is a **solar-powered mission**.
- It will complete a **12-year journey to eight different asteroids**
- The mission is designed to **understand the composition of the diverse asteroids** that are a part of the **Trojan asteroid swarms**, to determine the mass and densities of the materials and to look for and study the satellites and rings that may orbit the Trojan asteroids.

# Lucy: The First Mission to the Trojan

## Asteroids

- **No other space mission in history has been launched to as many different destinations** in independent orbits around our sun. Lucy will show us, for the first time, the diversity of the primordial bodies that built the planets.

# Lucy: The First Mission to the Trojan Asteroids

## About Trojan Asteroids:

- These asteroids are believed to be the **remnants of the early solar system**, and studying them will help scientists understand its origins and evolution, and why it looks the way it does.
- The Trojan asteroids are believed to be **formed from the same material** that led to the formation of planets nearly 4 billion years ago when the solar system was formed.

# ARIES facility will host the support centre for Aditya-L1

- The Indian programme to study the Sun and the region between the Sun and the Earth from space – Aditya-L1 – is due to be launched next year.
- It will carry seven payloads which have been developed by various institutions across the country.
- **Once the mission is launched, there will be a need for a ground support centre to monitor and coordinate the work on its various payloads.**
- This **role will be played by the ARIES facility** (short for Aryabhata Research Institute for observational Sciences) which is situated near **Nainital**

# ARIES facility will host the support centre for Aditya-L1

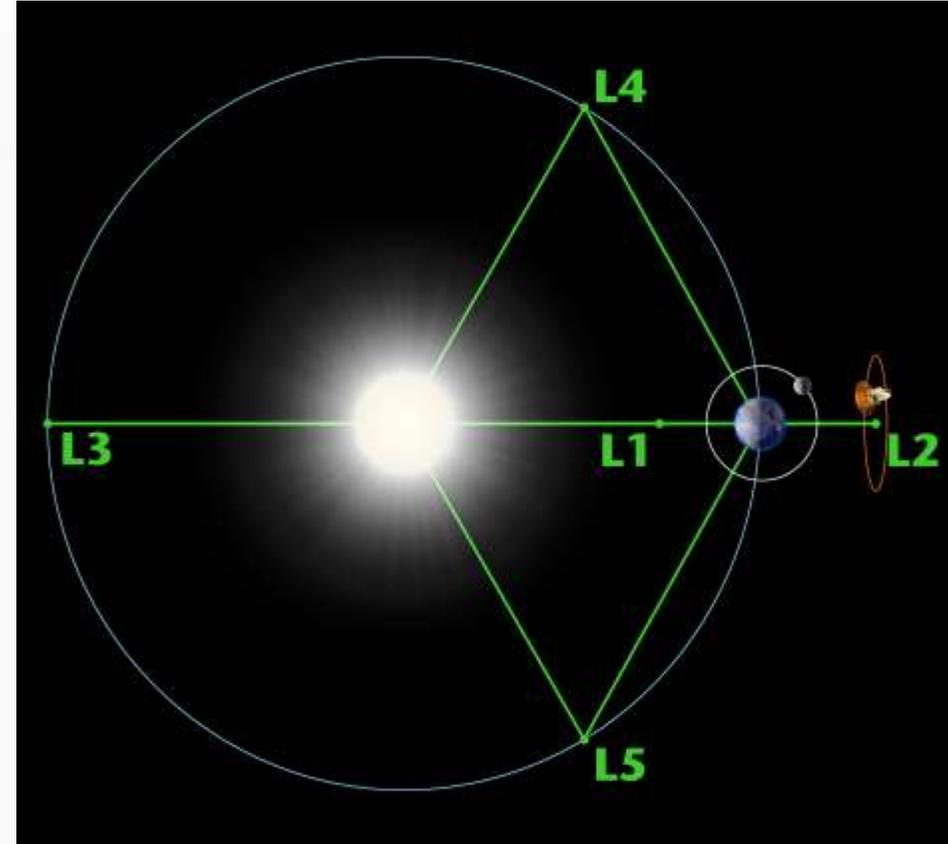
## Guest users

- Researchers who may **not even be associated with core Aditya-L1 team** will be able to book a specific payload to conduct observations for a particular time.
- Any PhD student or postdoctoral fellow in a research institution can submit observing proposals through the online proposal submission system.
- The **main aim of this centre is to let every researcher in India perform analysis over scientific data obtained from Aditya-L1.**

# ARIES facility will host the support centre for Aditya-L1

## Aditya L1

- It will be launched using the **Polar Satellite Launch Vehicle (PSLV)** in XL configuration.
- study the **Sun's corona, solar emissions, solar winds and flares**, and Coronal Mass Ejections (CMEs), and will carry out round-the-clock imaging of the Sun.



# ARIES facility will host the support centre for Aditya-L1

**Aryabhata Research Institute of Observational Sciences  
(Estb 1954)**

- ARIES is a leading research institute which specializes in **Astronomy, Astrophysics and Atmospheric Sciences**.
- It is an **autonomous body under the Department of Science and Technology (DST)**, Government of India.
- It is situated at **Manora Peak, in Nainital**, Uttarakhand.

# The 'whitest ever' paint that can reflect 99% of sunlight

- Engineers from Purdue University in the **US** have created what they are calling the **whitest paint** yet.
- Buildings coated with this paint may be able to **cool them off enough to reduce the need for air conditioning**, the researchers have said

## What is the whitest paint?

- The team of researchers at the university created an ultra-white paint in October pushing the limits of how white paint can be. This **older formulation was made of calcium carbonate**, while the **new one is made up of barium sulphate, which makes it more white**
- The team has also claimed that this paint may be **the closest equivalent to the blackest black paint called "Vantablack"** that is able to absorb up to 99.9 per cent of visible light.

# The 'whitest ever' paint that can reflect 99% of sunlight

How do we see colours and what determines if a colour absorbs or reflects light?

- Whenever an object is seen by the eye, it is either because of **sunlight or the artificial light in the room.**
- This **light is made up of seven different colours** (Violet, Indigo, Blue, Green, Yellow, Orange and Red or VIBGYOR).
- Specifically, **light is made up of wavelengths** of different colours.

# The 'whitest ever' paint that can reflect 99% of sunlight

## Green colour of Sofa

- If an individual is **looking at a sofa that is green**, this is because the fabric or **material it is made up of is able to absorb all the colours except green**.
- This means that the molecules of the **fabric reflect the green coloured** wavelengths, which is what the eye sees.
- Therefore, the **colour of any object or thing is determined by the wavelength the molecules are not able to absorb**.

# The 'whitest ever' paint that can reflect 99% of sunlight

## White colour

- For instance, if a person is looking at a bowl of vanilla ice cream or a plain white wall, it is because the molecules that make up these two **are absorbing none of the wavelengths of light**.
- This means, the **entire spectrum of these coloured wavelengths if reflected from the surface**, results in the white colour that the eye notices.

# The 'whitest ever' paint that can reflect 99% of sunlight

## Black colour

- In contrast, if an object is black, it is because it has **absorbed all the wavelengths** and therefore **no light is reflected from them**.
- This is the **reason that darker objects, as a result absorbing all wavelengths** tend to **heat up faster** (during absorption the light energy is converted into heat energy).

# The 'whitest ever' paint that can reflect 99% of sunlight

What determines which wavelength of light will be reflected and absorbed?

- This is dependent on **how electrons are arranged in an atom** (the building block of life, an atom is made up of electrons, protons and neutrons).
- These **three particles make up everything** in the known universe from mountains, planets, humans to pizza and cake).

# The 'whitest ever' paint that can reflect 99% of sunlight

what makes the paint so white?

- There are two features, one is the **paint's high concentration of a chemical compound called barium sulfate**, which is also used to make photo paper and cosmetics white.
- The second feature is that the team has used **different sized particles of this chemical compound**, which means different sizes scatter different amounts of light.
- In this way, a varying size of particles of the compound **make sure that the paint can scatter more of the light spectrum from the sun.**
- The paint can **keep surfaces 19 degrees Fahrenheit cooler than their ambient surroundings** at night.

# Akash prime missile

Defence Research and Development Organisation (DRDO) has successfully tested a new version of Akash missile named Akash Prime

## Akash Missile

- Akash Missile has the capability to engage aerial threats up to the **maximum range of 25 km** and up to an altitude of 20 km, operating at a speed **range of 1.8 to 2.5 Mach**
- **Medium** range
- Akash is India's **first indigenously(96%) produced medium range Surface-to-Air missile** that can engage multiple targets from multiple directions
- The missile is supported by the indigenously developed **radar called Rajendra**
- Akash uses **ramjet** propulsion system which can intercept the target at supersonic speed without deceleration
- Developed as part of India's Integrated Guided-Missile Development Programme (IGMDP).



# Mach Number

Glenn  
Research  
Center

$$\text{ratio} = \frac{\text{Object Speed}}{\text{Speed of Sound}} = \text{Mach Number}$$



**Subsonic**  
Mach < 1.0

**Transonic**  
Mach = 1.0



**Supersonic**  
Mach > 1.0



**Hypersonic**  
Mach > 5.0

|                       |  |
|-----------------------|--|
| Other Radars          |  |
| <b>INDRA Radar</b>    | <ul style="list-style-type: none"><li>• The Indian Doppler Radar (INDRA) series of <b>2D radars</b> were developed by India's DRDO for the Army and Air Force.</li><li>• The INDRA-I is a <b>mobile surveillance radar</b> for <b>low level target</b> detection while the</li><li>• INDRA-II is for <b>ground controlled interception</b> of targets.</li></ul>   |
| <b>RAJENDRA Radar</b> | <ul style="list-style-type: none"><li>• It is a multifunction electronically scanned phased array Radar which is the <b>heart of Aakash Air Defence System</b>.</li><li>• It is a <b>passive electronically scanned array (PESA)</b> radar and is used to guide Aakash missile to its target.</li></ul>  |
| <b>ROHINI Radar</b>   | <ul style="list-style-type: none"><li>• <b>3D medium range air surveillance radar</b> providing detection and tracking air targets even under hostile operational environment.</li><li>• It is capable of <b>handling multiple targets simultaneously</b> and also precisely calculate the height at which projectiles are flying.</li><li>• Mounted on <b>Tatra mobile platform</b>, a heavy duty modified truck built by the public sector Bharat Earth Movers Limited (BEML)</li><li>• Operating in a <b>range of upto 170 kilometres</b> and an altitude of <b>15 kilometres</b>, the Rohini radar can track multiple targets like fighter jets and missiles travelling at <b>supersonic speeds of over 3,000 kms per hour</b></li></ul> |

# Akash prime missile

## Akash-NG

- Developed by Defence Research & Development Laboratory (DRDL), Hyderabad in collaboration with other DRDO laboratories.
- **surface-to-air Missile.**
- **can strike targets at a distance of around 60 km and fly at a speed of up to Mach 2.5.**
- **The weight of the rocket has been brought down from 700 kg to 350 kg**
- **It uses a two-pulse solid rocket motor that replaces the old ramjet**
- **It has new seeker head to locks onto the enemy aircraft and continuously guides the missile to impact the target.**

# Akash prime missile

## The Akash Prime

- It has the **same range as that of the earlier version** but has a crucial new addition – that of an **indigenous active Radio Frequency (RF) seeker** for improved accuracy to hit aerial targets.
- Other improvements in the system ensures **more reliable performance under low temperature environments at higher altitudes**

# Man Portable Anti Tank Guided Missile (MPATGM)

## Man Portable Anti Tank Guided Missile (MPATGM)

- Indigenously-developed **anti-tank guided missile**
- **Low weight, fire and forget missile**
- Incorporated with state-of-the-art **Miniaturized Infrared Imaging Seeker**
- **Maximum range of 2.5 km** with a launch weight of less than 15 Kg.



# NAG Missile

- The **final user trial of Nag was successfully carried out at the Pokhran range in Rajasthan.**
- It is India's third-generation, **anti-tank guided missile.**

## Features:

- All-weather, fire-and-forget, lock-on after launch, with an **operational range of 500 m to 20 km.**
- It has a **single-shot hit probability of 90%.**
- It has a top speed of 230 meter/second (or 828 km/hour).

## Nag variants (Range)

### Prospina (500m-4km):

- Prospina, the **land version** meant for infantry, can be launched from a tracking-cum-launch vehicle known as NAMICA (Nag Missile Carrier).
- The launch system is mounted on light infantry **vehicle BMP-2 and can carry up to six missiles**. Each launcher can fire four missiles in one minute.

### HeliNa (7-10km):

- It is a **helicopter-launched version of NAG** with an extended range.
- The launch system is mounted on **HAL "Rudra" helicopter** using "Rudrastra" twin-launcher system and HAL Light Combat Helicopters.

## **Helina (SANT) (15-20 km):**

- This is an **upgraded version of the third-generation Helina** with an **extended range**.
- The higher range and a **new nose-mounted radar seeker** help the missile launch platform stay at a safe distance, to evade enemy fire.

## **Man Portable Anti-tank Guided Missile (MPATGM):**

- This version is lighter (14.5 kg) in comparison to other variants and can be launched from the shoulder. It has a strike range of 2.5 km.

# Rudram

- It is the **first indigenous anti-radiation missile developed by DRDO.**
- It is an **air-to-surface missile**, designed and developed by the DRDO
- Anti-radiation missiles are **designed to detect, track and neutralise the adversary's radar, communication assets and other radio frequency sources**, which are generally part of their air defence systems.
- Rudram-1 is the **first indigenous anti-radiation missile** of the country.

# Rudram

- It can be **launched from a height ranging from 500 metres to 15 km**. With this, IAF now has the capability to perform SEAD (Suppression of Enemy Air Defence) operations deep into enemy territory to destroy enemy air defence setup.

# Brahmos Supersonic Cruise Missile

- India successfully **test-fired** a **land-attack** version of **BrahMos** **supersonic cruise missile**.
- Supersonic includes speeds up to five times faster than the speed of sound.
- **Cruise missiles are Self-propelled** till the end of flights and are used to deliver large warheads over long distances with high precision.
- .

# Brahmos Supersonic Cruise Missile

- According to DRDO, BrahMos is a “universal, long-range supersonic cruise missile system that can be launched from land, sea and air”.
- Its anti-ship, land-attack and air versions are already operational with the Indian Navy, Army and Air Force while a submarine-launch version was trialled in 2013 by way of a test carried out from a submerged barge.

# Brahmos Supersonic Cruise Missile

## BrahMos:

- BrahMos is a joint venture between the **Defence Research and Development Organisation of India (DRDO)** and the **NPOM of Russia**.
- BrahMos is named on the **rivers Brahmaputra and Moskva**.
- It is a **two-stage** (solid propellant engine in the first stage and liquid ramjet in second) missile.

# Medium-Range Surface-to-Air (MRSAM) Missile

Recently, the maiden test of the **Medium Range Surface to Air Missile (MRSAM)** for the **Indian Army** has been conducted.

- MRSAM, developed by the DRDO in collaboration with **Israel Aerospace Industries (IAI)** for the **Army**, has been tested successfully.
- The propulsion system, coupled with a thrust vector control system, allows the missile to **move at a maximum speed of Mach 2**.
- It is a high response, quick reaction, **vertically launched supersonic missile**, designed to **neutralize enemy aerial threats** - missiles, aircraft, guided bombs, helicopters.
- It is a **land based variant of the Barak Air and Missile Defence System (AMD)**.

# Shaurya Missile

- India successfully test fired its indigenously developed **nuclear capable hypersonic missile 'Shaurya'** with a strike range of around 1,000 km.
- Shaurya is a **land variant of short-range** Submarine Launched Ballistic Missile (SLBM) **K-15 Sagarika**, which has a range of at least 750 kilometers.
- It is capable of carrying payloads of 200 kg to 1000 kg.
- It is a **surface-to-surface** tactical missile

## Python-5 Missile (Fifth generation air-to-air missile )

- Developed by the **Israeli defence company Rafael Advanced Defense Systems.**
- Can be launched from **very short to beyond-visual ranges** with greater kill probability
- Speed upto **Mach 4** and an operational range of more than 20 km.
- Dual use missile suitable for **air-to-air and surface-to-air missions.**
- Equipped with lock-on-before launch (LOBL) and lock-on-after launch (LOAL) capabilities

# Agni-P missile

A new-generation nuclear-capable ballistic missile, **Agni-P (Prime)** was **successfully test-fired** by the Defence Research and Development Organisation (DRDO)

## Agni-P

### High accuracy

- Many advanced technologies **including composites, propulsion systems, innovative guidance and control mechanisms** and state-of-the-art navigation systems have been introduced.
- The Agni-P missile **would further strengthen India's credible deterrence capabilities**
- There is a complete technology upgrade in every way.

# Shot in the arm

▶ Agni-P's range of 1,000–2,000 km is too short to reach targets in China's mainland, but can cover all of Pakistan's territory

▶ Being a canisterised missile, it can be transported easily and fired at very short notice

▶ It will replace the Prithvi, Agni-1 and Agni-2 missiles in India's arsenal that were built two decades ago with tech now considered obsolete

▶ It will enter service as a two-stage, solid propellant missile. Both stages will have composite rocket motors and guidance systems with electro-mechanical actuators

▶ Agni-P and Agni-5 originate from the Integrated Guided Missile Development Programme launched by then DRDO chief Dr APJ Abdul Kalam in the early 1980s