Space missions for exoplanet

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***Source**: The Hindu*

Manifest pedagogy: As a part of science & technology and geography, questions related to space have been asked both at prelims and mains stage. Finding life in other celestial bodies had always been a human curiosity. Origin of the solar system, exoplanets as prospective resources zone, finding life etc are key objectives of NASA and other space programs.

In news: European Space Agency (ESA) has launched CHEOPS exoplanet mission

Placing it in syllabus: Exoplanet space missions

Static dimensions: What are exoplanets?

Current dimensions:

- Exoplanet missions by NASA
- Exoplanet missions by ESA and CHEOPS mission

Content:

What are Exoplanets?

- The **worlds orbiting other stars** are called “exoplanets”.
- They **vary in sizes,** from gas giants larger than Jupiter to small, rocky planets about as big around as Earth.
- They **can be hot** enough to boil metal **or locked in deep freeze.**
- They **can orbit two suns at once.**
- **Some exoplanets are sunless,** wandering through the galaxy in permanent darkness.
- The **first exoplanet invented was 51 Pegasi b**, a “hot Jupiter” in **1995** which is 50 light-years away that is locked in a four-day orbit around its star. ((*The*

*discoverers Didier Queloz and Michel Mayor of 51 Pegasi b shared the **2019 Nobel Prize in Physics** for their breakthrough finding)*).

- And a system of three "pulsar planets" had been detected, beginning in 1992.
- The **circumstellar habitable zone (CHZ) also called the Goldilocks zon**e is the range of orbits around a star within which a planetary surface can support liquid water given sufficient atmospheric pressure.
- The **bounds of the CHZ are based on Earth's position in the Solar System** and the amount of radiant energy it receives from the Sun.
- The nature of the CHZ and the objects within are instrumental in determining the scope and distribution of planets capable of supporting Earth-like extraterrestrial life and intelligence.
- Among exoplanets, a review in 2015 came to the conclusion that **Kepler-62f, Kepler-186f and Kepler-442b** were likely the **best candidates for being potentially habitable.**
- As of now, the count of confirmed exoplanets is around 3,700, and is rising.

Exoplanet missions by NASA:

Kepler:

- The spacecraft was launched on March 7, 2009 which leaves a **legacy of more than 2,600 planet discoveries from outside our solar system,** many of which could be promising places for life.
- In 2018, NASA retired the spacecraft within its current, safe orbit, away from Earth.

K2:

- The K2 mission became fully operational in June 2014 and ended space operations in 2018.

- It **enabled continued scientific observations with the Kepler space telescope.**

Transiting Exoplanet Survey Satellite (TESS) mission:

- It was launched on April 18, 2018 which will **look for planets orbiting the brightest stars in Earth's sky**.
- It employs the **transit method to detect exoplanets**. This method looks for dips in the visible light of stars and requires that planets cross in front of stars along our line of sight to them. Repetitive, periodic dips reveal a planet or planets orbiting a star.
- TESS **has now detected 993 potential exoplanets and 28 confirmed ones.**

NN-EXPLORE program:

- It is to provide the astronomy community with the **tools and access to conduct ground-based observations** that advance exoplanet science.
- Particular emphasis is on **Kepler, K2, and TESS** follow-up observations, as well as observations that inform future NASA missions.

LBTI instrument:

- Large Binocular Telescope Interferometer (LBTI) is a **NASA-funded instrument to study exoplanetary systems.**
- It is located at the Large Binocular Telescope (LBT, Mount Graham, Arizona).

Hunt for Observable Signatures of Terrestrial Systems (HOSTS):

- It is a **NASA-funded survey of mid-infrared emission from exozodiacal dust** in the habitable zones of nearby main sequence stars.
- Its **goal** is to inform the design of a future space mission to directly detect and characterize exo-Earths.

LBTI Exoplanet Exo Zodi Common Hunt (LEECH):

- It is a **high contrast direct imaging survey of exoplanets** around nearby stars.
- The LEECH **includes observations in parallel with HOSTS**, thereby directly studying both the exozodi and exoplanet architectures around the same stars.

Future missions:

James Webb Space Telescope:

- It scheduled for the 2020s and is a space telescope that is planned to be the **successor to the Hubble Space Telescope**.
- It will probe the distant Universe in the **infrared part of the spectrum** with its large mirror.
- It will be a powerful tool for studying the atmospheres of distant worlds and **direct imaging of exoplanets and novas.**

TARdYS (the Tao Aiuc high Resolution d Y band Spectrograph):

- It is a **fiber-fed infrared echelle spectrograph** planned to be installed at the TAO 6.5-meter telescope in **Chile**.
- The telescope and spectrograph are currently under construction.
- TARdYS will open up opportunities for **high-resolution Y-band infrared spectroscopy including studies of M-dwarfs** and searches for their planets.

Exoplanet mission by European Space Agency (ESA) and the CHEOPS mission:

- Cheops is ESA's **CHaracterising ExOPlanet Satellite**.
- The 1.5 m probe is the **first dedicated ESA mission to study exoplanets.**
- Cheops is a Small or **S-class** mission in ESA's science programme ((S-class missions have a much smaller budget than Large- and Medium-class missions, and a much shorter time from project start to launch)).

- It is a **partnership between ESA and Switzerland,** with important **contribution from 10 other ESA Member States.**
- The mission is in order to **make high-precision observations of the planet's size** as it passes in front of its host star.

- CHEOPS will **measure the brightness of the stars, looking for tiny dips associated with a transit** – when an exoplanet passes in front of its star, blocking some of the light that reaches Earth.
- Rather than search for new planets, CHEOPS **will study about 500 of the 4000 or so known exoplanets during a 3.5-year period.**
- CHEOPS **contains a single optical Ritchey–Chrétien telescope** with an aperture of 30 cm.
- It will **measure the radius of exoplanets that have a mass of between Earth and Neptune** to an accuracy of around 10%.
- The probe will **also study the atmosphere of larger planets** – those that are around the size of Jupiter.
- The **first data is expected in early 2020.**

Future missions:

PLAnetary Transits and Oscillations of stars (PLATO):

- It is a space telescope under development for **launch in 2026.**
- The mission goals are to **search for planetary transits across up to one million stars,** and to discover and **characterize rocky extrasolar planets** around yellow dwarf stars, subgiant stars, and red dwarf stars.

Atmospheric Remote-sensing Infrared Exoplanet Large-survey (ARIEL):

- It is a space telescope **planned for launch in 2028** as

the **fourth medium-class mission** of the ESA’s Cosmic Vision programme.

- It is aimed at observing at least 1,000 known exoplanets using the transit method, **studying and characterising the planets’ chemical composition and thermal structures**.