MACE Telescope in Ladakh

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Why in News?

Recently, the **Major Atmospheric Cherenkov Experiment (MACE) telescope** was inaugurated in **Hanle**, **Ladakh**, representing a significant advancement in **gamma-ray astronomy**.

- It enables scientists to **explore gamma rays** with energies **exceeding 20 billion electron volts (eV)**, emitted from sources **beyond the Milky Way**, including **pulsars**, **blazars**, and **gamma-ray bursts**.

What are the Key Features of MACE?

- **About MACE:**
  - Positioned at an **altitude of approximately 4.3 kilometers**, MACE is the highest imaging Cherenkov telescope globally, making it the **largest of its kind in Asia and the second-largest worldwide**.
  - The **MACE** uses an **Imaging Atmospheric Cherenkov Telescope (IACT)** to detect high energy gamma rays indirectly.
    - When high-energy gamma rays enter Earth's atmosphere, they create **electron-positron pairs**, producing Cherenkov radiation.
    - MACE captures this **faint blue light (Cherenkov radiation)** with its sophisticated equipment.
    - Its light collector, composed of **356 mirror panels in a honeycomb structure**, enhances stability and reflective area.
- **Research Objectives:**
  - The **primary goal is to study high-energy gamma rays from cosmic sources**.
  - MACE seeks to understand **dark matter** by detecting gamma rays from **weakly interacting massive particles (WIMP)** annihilation events and investigating WIMPs, which may constitute much of the universe's mass.
- **Institution Involved:**
  - **Bhabha Atomic Research Centre (BARC)**
  - **Indian Institute of Astrophysics**
- **Technological Innovations:**
  - The telescope features a **high-resolution camera with 1,088 photomultiplier tubes** that detect and amplify faint signals from Cherenkov radiation.
  - Its altitude provides a clear view above atmospheric disturbances, enhancing its observational capabilities.

Telescopes

- A telescope is an optical instrument designed to observe distant objects by collecting and magnifying light or other forms of electromagnetic radiation.
- There are various types of telescopes, including **optical telescopes (which observe visible light), radio telescopes (which detect radio waves), and gamma-ray telescopes (which capture high-energy gamma rays).**

Gamma Rays and Related Health Hazards

- **Gamma rays**, high-energy **electromagnetic radiation**, can penetrate most materials, including human tissue, posing health risks.
    - Gamma rays have **the shortest wavelength and the highest energy,** with each light-particle possessing more than 100,000 electron volts.
    - **Gamma rays are produced by exotic energetic objects** in the cosmos, including rapidly spinning pulsars, supernova explosions, hot whirlpools of matter around black holes, and gamma-ray bursts.
    - They are also emitted during **radioactive decay** or **nuclear reactions**.
- Exposure to gamma rays can **damage cells and DNA**, leading to radiation sickness, increased **cancer** risk, and other long-term effects.

What are other Similar Telescope Projects?

- **Indian Astronomical Observatory (IAO):**
    - The **IAO**, located in Hanle, is one of the highest astronomical observatories in the world. It is operated by the **Indian Institute of Astrophysics (IIA)** and features several telescopes, including the **Himalayan Chandra Telescope (HCT)**.
- **Dark Sky Reserve:**
    - A **Dark Sky Reserve** is a designation given to a place that has policies in place to ensure that a tract of land or region has minimal artificial light interference.
- **High Altitude Gamma Ray (HAGAR):**
    - **HAGAR,** located at 4270 m in Hanle, Ladakh, is the **first high-altitude gamma-ray telescope array** designed by utilizing the atmospheric **Cherenkov technique**. It was designed for a **low energy threshold** with a minimal mirror area.
- **Giant Metrewave Radio Telescope:**
    - **GMRT** is an array of thirty fully steerable parabolic radio telescopes of 45 metre diameter. It is operated by the National Centre for Radio Astrophysics of the Tata Institute of Fundamental Research.

UPSC Civil Services Examination Previous Year Question (PYQ)

Prelims

Q. Consider the following phenomena: (2018)

1. Light is affected by gravity.
2. The Universe is constantly expanding.
3. Matter warps its surrounding space-time.

Which of the above is/are the prediction/predictions of Albert Einstein's General Theory of Relativity, often discussed in media?

(a) 1 and 2 only

(b) 3 only

(c) 1 and 3 only

(d) 1, 2 and 3

Ans: (d)

Q. Recently, scientists observed the merger of giant ‘blackholes’ billions of light-years away from the Earth. What is the significance of this observation? (2019)

(a) ‘Higgs boson particles’ were detected.

(b) ‘Gravitational waves’ were detected.

(c) Possibility of intergalactic space travel through ‘wormhole’ was confirmed.

(d) It enabled the scientists to understand ‘singularity’

Ans: (b)