Atacama Large Millimeter/submillimeter Array (ALMA) Telescope

Prelims: *Current events of national and international importance | Science & Technology*

Why in News?

Recently, astronomers have released the largest-ever ALMA image of the Milky Way's central region under the ACES – ALMA Central Molecular Zone Exploration Survey.

- **Location –** It is located in the ***Atacama Desert, Chile.***
- Located at an altitude of about 5,000 metres on the Chajnantor Plateau.
- The location is ideal for ***radio astronomy*** due to high altitude and extremely dry conditions.
- **Purpose –** Formation of stars and planets, Molecular clouds and protoplanetary disks, Early galaxies in the universe and Chemical composition of space.
- **Operational Since –** 2013.
- **Collaboration –** ALMA is a joint international venture–
  - Led by European Southern Observatory (Europe)
  - U.S. National Science Foundation (NSF)
  - National Institutes of Natural Sciences (Japan)
  - In cooperation with the Republic of Chile
- **Core Specifications -** It is ***not a single telescope but an interferometer***—a network of 66 high-precision antennas that work together as one giant instrument.

Feature	Detail
Antennas	66 total (54 are 12m diameter; 12 are 7m diameter)
Wavelengths	0.32 mm to 3.6 mm (Millimeter and submillimeter)
Max Baseline	Antennas can be spread up to **16 km** (10 miles) apart
Resolution	***Up to 10 times sharper*** than the Hubble Space Telescope

Supercomputer	The **ALMA Correlator**, one of the fastest in the world

- **Technique -** It uses a technique called interferometry. By combining the signals from multiple antennas, it mimics a single telescope with a diameter equal to the distance between the furthest antennas.

Key Findings Using ALMA

- **Largest-Ever High-Resolution Map – *First time the entire Central Molecular Zone (CMZ) has been mapped*** in such detail.
- **Area Covered –** Over 650 light-years across the CMZ.
- **Size –** Mosaic equivalent to 3 full Moons side-by-side in sky coverage.
- **Discovery of Filamentary Gas Network –** Long, thin streams of cold molecular gas detected.
- Gas flows along filaments feeding star-forming regions.
- Reveals how matter moves toward dense star-forming clumps.
- **Hidden Astrochemistry Uncovered –** Detection of dozens of molecules, including –
  - **Simple molecules –** Silicon monoxide (SiO)
  - **Complex organic molecules –** Methanol, Ethanol, Acetone.
- Indicates rich chemical complexity in extreme environments.
- **Star Formation Paradox –** Despite having very high gas density, the CMZ of the Milky Way forms *stars at a much lower rate than predicted by standard star-formation models.*

References

1. The Guardian | ALMA Telescope
2. ESO | Largest image of the heart of the Milky Way