Progresses and future of China’s Space Science Missions

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Themes of China’s Space Science Missions

Theme 1: How did the universe and life originate, how does it evolve?

How did the universe originate and how does it evolve?
How did life originate and how does it evolve?
What are the law of matter motion and the law of life activity in space environment?

Theme 2: What is the relationship between solar system and human being?

What is the nature of solar activity?
What is the origin and evolvement of solar system, and its relationship with the sun?
How does the earth system evolve?
Roadmap of China’s Space Science Missions

- DAMPE (2015)
- QUESS (2016)
- SJ-10 (2017)
- HXMT (2017)
- GECAM (2020)
- ASO-S (2021)
- EP (2022)
- SMILE (2024)

Strategic Priority Program on Space Science (I)

Strategic Priority Program on Space Science (II)
DARK MATTER PARTICLE EXPLORER (DAMPE)

Launch: Dec. 17, 2015

- Operation for 3 yrs
- Extension of 2 yrs

A satellite-borne, high-energy particle and γ-ray detector, dedicated to indirectly detecting particle dark matter and studying high-energy astrophysics.
Recorded 6.15 billion cosmic rays events with broad and fine energy spectrum

Direct detection of a break in the Tev cosmic-ray spectrum of electrons and positrons

Detection of a spectral break at ~10 TeV in the proton spectrum (2019)


Sci Adv 5(9), 2019
The 24th recoverable satellite of China, provides 19 space microgravity experiments

- Microgravity fluid physics
- Microgravity combustion
- Space material
- Space radiation effects and space biotechnology

Recoverable Satellite for Microgravity and Space Life Sciences (SJ-10)

Mission in operation April 6-18, 2016
Development of mouse embryos in space

National Science Review, 2020, 7, 1437-1446
• **Scientific Objectives:**
  – Implementation of long-distance quantum communication network
  – Quantum entanglement distribution and quantum teleportation
  – Fundamental tests of the laws of quantum mechanics

• Launch: Aug. 16, 2016
• Orbit: 500km, sun-synchronous
• Status: in extended operation
Entanglement-based secure quantum cryptography between two ground stations separated by 1120 km was demonstrated. Nature, 2020, 582: 501-505

An integrated space to ground quantum communication network over 4600 km was demonstrated. Nature, 2021, 589: 214-219
Science Objectives

• **Galactic plane scan and monitor survey** for more weak & short transient sources in very wide energy band (1-250 keV)

• **Pointed observations**: High statistics study of bright sources and Long-term high cadence monitoring of XRB outbursts

• **Multi-wavelength Observations** with other telescopes

• GRBs and GW EM, FRB, etc.

**Hard X-ray Modulation Telescope (HXMT)**

Launch: Jun. 15, 2017
Discovered a low-frequency quasi-periodic oscillation above 200 keV in a black hole binary, the highest energy low-frequency QPO ever found.

Nature Astronomy, 2020
Detected the strongest magnetic field in the universe (\sim 1B T)
Launched 31 Aug, 2019

China’s first technology demonstration mission for GW detection from space

Drag-free control experiments
Gravitational wave high-energy Electromagnetic Counterpart All-sky Monitor (GECAM)

- Independent confirmation of GW event
- Accurate localization, host galaxy, redshift
- Astrophysical content of the GW source
- GW+EM, Cosmology, fundamental physics

- Two satellites in conjugate orbit
- Monitor all-sky GRB

Dec. 10, 2020
Einstein Probe (EP)

exploring the dynamic X-ray universe

- Carry out systematic survey of soft X-ray transients and variability of X-ray sources at unprecedented sensitivity and high cadence

- Launch: 2023
Advanced Space-borne Solar Observatory (ASO-S)

Science Objectives
- Relationship between solar magnetic field and solar flares
- Relationship between solar magnetic field and CMEs
- Relationship between solar flares and CMEs

Payloads
- Full-Disc Vector Magnetograph (FMG): solar magnetic field
- Hard X-ray Imager (HXI): solar flare
- Lyman-alpha Solar Telescope (LST): CME

Launch: 2022
Investigate the dynamic response of the Earth’s magnetosphere to the solar wind impact in a unique and global manner.
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- How does the earth system evolve?

EP GECAM

ASO-S

SMILE
Calling Taikong 2035

- **Extreme Universe**
  - eXTP
  - Dark Matter Particle Exploration

- **Space-Time Ripple**
  - GW detection mission Pathfinder
  - GW detection Constellation

- **Sun-Earth Panorama**
  - 3D-Solar Image
  - Geospace-Earth multiple spheres and cycles coupling exploration
  - Exploration of the Solar System Edge

- **Habitable Planets**
  - Earth 2.0
  - Search for habitable planets

- **Timeline**
  - 2025
  - 2030
  - 2035

[Image: National Space Science Center, CAS]
To explore the unknown, we are open for cooperation. It's for science!