Dark Matter Particle Explorer (DAMPE): The First Chinese Astronomical Satellite

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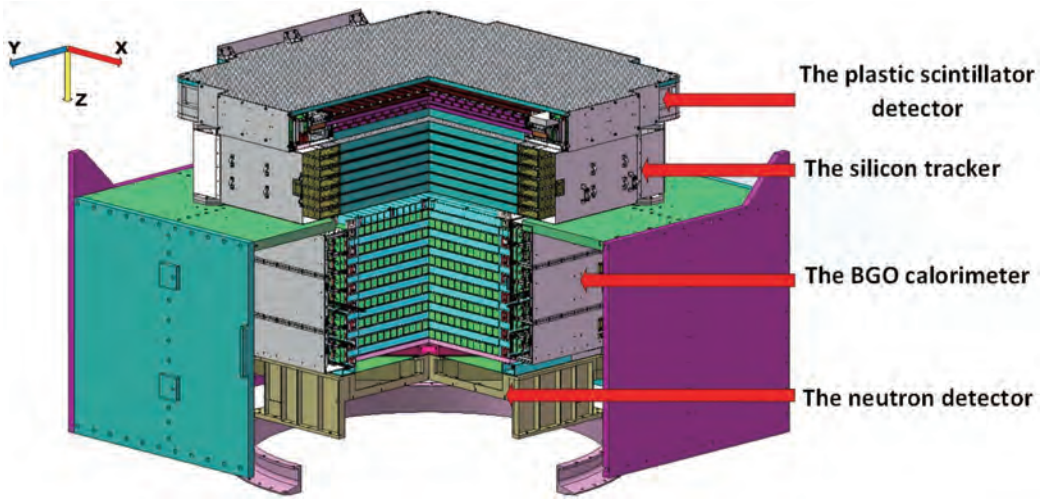

Fig. 1: Side view of the DAMPE detector.

The Dark Matter Particle Explorer (DAMPE), also known as "Wukong" (the famous "Monkey King" in China), is a space mission supported by the Strategic Priority Science and Technology Projects in Space Science Program of the Chinese Academy of Sciences. The DAMPE detector consists of four parts, including a plastic scintillator strip detector that serves as an anti-coincidence and charge detector, a silicon-tungsten tracker-converter that measures the direction of an incident particle, a BGO imaging calorimeter of about 31 radiation lengths that measures energy with high resolution and distinguishes electrons from protons, and a neutron detector that further improves particle identification (see Fig. 1). The detector was developed collaboratively, with primary hardware and software responsibilities shared by Purple Mountain Observatory, the University of Science and Technology of China, the Institute of Modern Physics, the Institute of High Energy Physics and the National Space Science Center, which are five institutions of the Chinese Academy of Sciences. Other institutions that have made significant contributions to instrument development (in particular the silicon-tungsten tracker-converter) include the University of Geneva, Istituto Nazionale di Fisica Nucleare (INFN) Bari, INFN Lecce and INFN Perugia.

DAMPE was successfully launched into a sun-synchronous orbit at an altitude of 500 km by the Long March 2D rocket on Dec. 17 2015 (see Fig. 2). All sub-detectors were turned on successfully on Dec. 24 2015 and they continue to work very well. The on-orbit calibration was finished on Mar. 17 2016 and since then DAMPE, which is the first Chinese astronomical satellite, has been delivered to its scientific collaboration. Its energy resolution and particle identification abilities at TeV energies are the best among similar experiments in the world. The on-orbit data also shows that the charge resolution and angular resolution are fully consistent with the expecta-

Fig. 2: The launch of the DAMPE (Wukong) satellite.

tions. DAMPE continues to collect GeV-TeV gamma-rays, electrons, protons and heavier cosmic ray nuclei at a rate of about 60 Hz in wide energy ranges with a large acceptance (see Table 1). After one year of performance, more than 1.8 billion high energy particles have been successfully re-constructed. The data is expected to advance our knowledge of the acceleration and propagation of cosmic rays in the Galaxy, the nature of dark matter, and the high-energy behaviors of active Galaxy nuclei, Galactic pulsars and other kinds of transients, as well as diffuse gamma-ray emissions.

Table 1: Summary of DAMPLE instrument parameters and Expected performance.

Parameter	Value of Range
Energy ranger of γ-rays/electrons	5 GeV–10 TeV
Energy resolution of γ-rays/electrons	≤ 1.5% at 800 GeV
Energy range of protons/heavy nuclei	50 GeV–100 TeV
Energy resolution of protons	< 40% at 800 GeV
Effective area at normal incidence (γ-rays)	1100 cm^2 at 100 GeV
Geometric factor for electrons (protons)	0.30 m^2 sr (0.07 m^2 sr) at 800 Gev
Single photon angular resolution[a]	≤ 0.3 degrce at 100 GeV
Field of View (FoV)	~ 1.0 sr

Note: a. For the 68% containment radius.

With a sun-synchronous orbit, DAMPE covers the full sky every half year, although the exposure is non-uniform. DAMPE will work in space for at least three years and the first results are expected to be available in 2017.

Jin Chang is the PI of the Dark Matter Particle Explorer (Wukong), the deputy director of Purple Mountain Observatory, and a visiting researcher at Kanagawa University and the Max-Planck Institute for Solar System Research. After graduating from the University of Science and Technology of China, he received a D.Sci from Purple Mountain Observatory and has since then worked at the observatory. His research field is astro-particle physics.