

will introduce the BITSE mission and discuss recent progress.

[7 NGSC-02] Optical Design, Test, and alignment of BITSE

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NASA and Korea Astronomy and Space Science Institute (KASI) have been collaborated to develop the Space solar coronagraph instrument to detect the solar wind speed and corona temperature. As an intermediate stage, BITSE is the Balloon-Borne instrument to prove our proposed technical method which uses a polarized light in 4 different bandwidth wavelengths. In the presentation, the optical design based on the requirements, tests and alignment process for integrating the system are discussed.

[7 NGSC-03] BITSE Instrument

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BITSE is a balloon mission, which is a solar coronagraph to measure speed and temperature of the solar wind using 4 different wavelength filters and an pixelated polarization camera. KASI and NASA jointly designed, developed, and tested the solar coronagraph. Mainly KASI developed an imaging system and a control system, and NASA developed an optical system and mechanical structures. We mount the BITSE on Wallops Arc-Second Pointer (WASP) of Wallops Flight Facility, and launch it with a 39 mcf balloon of Columbia Scientific Balloon Facility. We will introduce the overall system of the BITSE.

[7 NGSC-04] BITSE Filter Wheel Assembly using a Piezo-ceramic module

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Space applications of the motion have been served with DC motors for decades. But their functionality with a gearbox and lubricants and their weights are always an issue for its application. A piezo-motor has an advantage on the direct driving with higher accuracy, smaller size, and no-EMI. We use the piezo-motor to rotate a filter wheel directly in a balloon-borne coronagraph launched on September 2019. The piezo-motor works well in a temperature range from -10 to 40 Celsius with high reliability and high positioning / tilt accuracy (~0.1degree) with a photo-encoder. We verify its functionality for 7 days. In this talk, we report the design, test processes of the filter wheel including its balloon flight result.

[7 NGSC-05] Development of the Command and Data Handling System and Flight Software of BITSE

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BITSE is a project of balloon-borne experiments for a next-generation solar coronagraph developed by a collaboration with KASI and NASA. The coronagraph is built to observe the linearly polarized brightness of solar corona with a polarization camera, a filter wheel, and an aperture door. For the observation, the coronagraph is supported by the power distribution unit (PDU), a pointing system WASP (Wallops Arc-Second Pointer), telemetry & telecommand system SIP (Support Instrument Package) which are developed at NASA's Goddard Space Flight Center, Wallops Flight Facility, and Columbia Scientific Balloon Facility. The BITSE Command and Data Handling (C&DH) system used a cost-off-the-shelf electronics to process all data sent and received by the coronagraph, including the support system operation by RS232/422, USB3, Ethernet, and digital and analog signals. The flight software is developed using the core Flight System (cFS) which is a reusable software framework and set of reusable software applications which take advantage of a rich heritage of successful space

mission of NASA. The flight software can process encoding and decoding data, control the subsystems, and provide observation autonomy. We developed a python-based testing framework to improve software reliability. The flight software development is one of the crucial contributions of KASI and an important milestone for the next project which is developing a solar coronagraph to be installed at International Space Station.

[7 NGSC-06] BITSE Ground Software

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We have developed Ground Software (GSW) of BITSE. The ground software includes mission operation software, data visualization software and data processing software. Mission operation software is implemented using COSMOS. COSMOS is a command and control system providing commanding, scripting and data visualization capabilities for embedded systems. Mission operation software send commands to flight software and control coronagraph. It displays every telemetry packets and provides realtime graphing of telemetry data. Data visualization software is used to display and analyze science image data in real time. It is graphical user interface (GUI) and has various functions such as directory listing, image display, and intensity profile. The data visualization software shows also image information which is FITS header, pixel resolution, and histogram. It helps users to confirm alignment and exposure time during the mission. Data processing software creates 4-channel polarization data from raw data.

[7 NGSC-07] BITSE Preliminary Result and Future Plan

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BITSE is a technology demonstration mission to remotely measure the speed, temperature, and density of the solar wind as it forms as close as 3 Rs. BITSE obtained coronal images during its one

day flight above more than 99% of the atmosphere, and calibration data are taken in the laboratory as well as during the flight. As the linearly polarized K-corona is much fainter than other bright sources like diffraction, sky, and F-corona, a careful data reduction is required to obtain reliable scientific results. We will report status of the obtained data, the reduction progress, and future plan.

특별세션

Pillars of the Standard Model of Cosmology

[7 PSMC-01] Deviations from power-law primordial spectrum

Jinn-Ouk Gong
Korea Astronomy and Space Science Institute

We discuss theoretical motivations for deviations from standard power-law primordial power spectrum and possible mechanism to provide non-trivial scale dependence for the primordial power spectrum.

[7 PSMC-02] Testing the Curvature of the Universe

Benjamin L'Huillier
Yonsei University

In a homogeneous and isotropic universe, the solution to the Einstein Field equation is the Friedmann-Robertson-Lemaître-Walker metric, which describes an expanding Universe with spatial curvature. The curvature has profound implications, in particular regarding the early universe.

In this talk, I will review the state-of-the-arts constraints on the spatial curvature of the Universe using different cosmological observations. In particular, I will focus on model-independent tests using baryon acoustic oscillations and supernovae.

[7 PSMC-03] Candidates of cold dark matter

Ki-Young Choi
Sungkyunkwan University

The astrophysical and cosmological observations are consistent with the cold dark matter in the standard cosmology. I review the possible candidates of cold dark matter and their production in the early Universe with their possible