A sounding rocket mission concept to acquire high-resolution radiometric spectra spanning the 9 nm - 31 nm wavelength range

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Abstract -- When studying Solar Extreme Ultraviolet (EUV) emissions, both single-wavelength, two-dimensional (2D) spectroheliograms and multi-wavelength, one-dimensional (1D) line spectra are important, especially for a thorough understanding of the complex processes in the solar magnetized plasma from the base of the chromosphere through the corona. 2D image data are required for a detailed study of spatial structures, whereas radiometric (i.e., spectral) data provide information on relevant atomic excitation/ionization state densities (and thus temperature). Using both imaging and radiometric techniques, several satellite missions presently study solar dynamics in the EUV, including the Solar Dynamics Observatory (SDO), Hinode, and the Solar-Terrestrial Relations Observatory (STEREO). The EUV wavelengths of interest typically span 9 nm to 31 nm, with the shorter wavelengths being associated with the hottest features (e.g., intense flares and bright points) and the longer wavelengths associated with cooler features (e.g., coronal holes and filaments). Because the optical components of satellite instruments degrade over time, it is not uncommon to conduct sounding rocket underflights for calibration purposes. The authors have designed a radiometric sounding rocket payload that could serve as both a calibration underflight for and a complementary scientific mission to the upcoming Solar Ultraviolet Imager (SUVI) mission aboard the GOES-R satellite (scheduled for a 2015 launch). The challenge to provide quality radiometric line spectra over the 9-31 nm range covered by SUVI was driven by the multilayer coatings required to make the optical components, including mirrors and gratings, reflective over the entire range. Typically, these multilayers provide useful EUV reflectances over bandwidths of a few nm. Our solution to this problem was to employ a three-telescope system in which the optical components were coated with multilayers that spanned three wavelength ranges to cover the three pairs of SUVI bands. The complete system was designed to fit within the Black Brandt-IX 22”-diameter payload skin envelope. The basic optical path is that of a simple parabolic telescope in which EUV light is focused onto a slit and shutter assembly and imaged onto a normal-incidence diffraction grating, which then disperses the light onto a 2048 × 2048 CCD sensor. The CCD thus records 1D spatial information along one axis and spectral information along the other. The slit spans 40 arc-minutes in length, thus covering a solar diameter out to +/- 1.3 solar radii. Our operations concept includes imaging at three distinct positions: the north-south meridian, the northeast-southwest diagonal, and real-time pointing at an active region. Six 10-second images will be obtained at each position. Fine pointing is provided by the SPARCS-VII attitude control system typically employed on Black Brandt solar missions. Both before and after launch, all three telescopes will be calibrated with the EUV line emission source and monochromater system at NASA’s Stray Light Facility at Marshall Spaceflight Center. Details of the payload design, operations concept, and data application will be presented.
A sounding rocket mission concept to acquire high-resolution radiometric spectra spanning the 9 nm - 31 nm wavelength range

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Abstract - Abstract - When studying complex processes in the solar atmosphere, observations in the extreme ultraviolet (EUV) are important. Two forms of observations include single-wavelength and multi-wavelength one-dimensional (1D) line spectra. 2D image data facilitate a detailed study of spatial components, whereas radiometric (i.e., spectral) data provide information on relevant emission locations (e.g., solar flares and prominences). The EUV wavelength bands of interest typically span 9 nm to 31 nm, with the oxygen transitions being associated with the Fraunhofer lines (e.g., OI, I, I, I). The 2D image data are collected using a sounding rocket under flight in space, on-board computer for calibration purposes. The authors have designed a sounding rocket to acquire EUV images and have developed algorithms to analyze the data. The sounding rocket is intended to acquire high-resolution multi-wavelength images for calibration purposes. The authors have designed a sounding rocket to acquire EUV images and have developed algorithms to analyze the data.

Feasibility Study Objectives

PURPOSE: Outline and identify key elements of a suitable SUIV sounding rocket under flight configuration.

Key questions:

1. What are the mission requirements for the SUIV sounding rocket?
2. What are the main alternatives analyzed and which are the most suitable under flight program?
3. Are there any key risk analysis and mitigation strategies identified?

Initial Approach

Examination of SUIV performance requirements, research of possible deployment efforts due to long-term exposure to the GEO environment, and assessment of current solar calibration plans have prompted us to reconsider an imaging spectrometer approach for obtaining solar data using a 2D CCD camera with a combination of high-resolution spectrometer. The sounding rocket has a significant limitation in its ability to conduct the required solar observations. A sounding rocket mission concept to acquire high-resolution radiometric spectra spanning the 9 nm - 31 nm wavelength range.