SIHLA, a Mission of Opportunity to L1 to Map H Lyman Alpha Emissions from the Heliopause, the Interplanetary Medium, the Earth’s Geocorona and Comets

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Abstract

SIHLA (Spatial/Spectral Imaging of Heliospheric Lyman Alpha pronounced as ‘Scylla’ [e.g. Homer, Odyssey, 675-725 BCE]) investigates fundamental physical processes that determine the interaction of the Sun with the interstellar medium (ISM); the Sun with the Earth; and the Sun with comets and their subsequent evolution. To accomplish these goals, SIHLA studies the shape of the heliosphere and maps the solar wind in 3D; characterizes changes in Earth’s extended upper atmosphere (the hydrogen ‘geocorona’); discovers new comets and tracks the composition changes of new and known ones as they pass near the Sun. SIHLA is a NASA Mission of Opportunity that has just completed its Phase A study (the Concept Study Report or CSR). At the time of the writing of this abstract NASA has not decided whether to fly this small satellite mission or its competitor (GLIDE: PI Prof. Lara Waldrop). SIHLA observes the ion-neutral interactions of hydrogen, the universe’s most abundant element, from the edge of the solar system to the Earth, to understand the fundamental properties that shaped our own home planet Earth and the heliosphere. From its L1 vantage point, well outside the Earth’s obscuring geocoronal hydrogen cloud, SIHLA maps the entire sky using a flight-proven, compact, far ultraviolet (FUV) hyperspectral imager with a Hydrogen Absorption Cell (HAC). The hyperspectral scanning imaging spectrograph (SIS) in combination with the spacecraft roll, creates 4 maps >87% of the sky each day, at essentially monochromatic lines over the entire FUV band (115 to 180nm) at every point.
in the scan. During half of these daily sky maps, the hydrogen absorption cell (HAC) provides a 0.001nm notch rejection filter for the H Lyman a. Using the HAC, SIHLA builds up the lineshape profile of the H Lyman a emissions over the course of a year. SIHLA’s SIS/HAC combination enables us to image the result of the ion-neutral interactions in the heliosheath, 100 AU away, in the lowest energy, highest density, part of the neutral atom spectrum – H atoms with energies below 10eV. The novel aspects of SIHLA are the scope of the science done within a MoO budget. The SIHLA projected costs were below the $75M cap with a 31.3% reserve for Phase B-D. The re-purposing of a spectrographic that was part of the DMSP SSUSI line (a copy was flown and NASA TIMED/GUVI and as NASA NEAR/NIS). Risk is extremely low in this Class-D mission with all major elements at least at TRL6 at this time. SIHLA has a high potential for discovery. We expect that we will 1) First detection of the hot H atoms produced directly from the ion-neutral interactions at the heliopause; 2) First detection of structures in Interplanetary Medium H emission, 3) First detection of response of the Earth’s extended (out to lunar orbit) geocorona to solar/geomagnetic drivers, 4) New UV-bright comets as they enter the inner solar system. SIHLA is a hyperspectral imager; at every point in the sky SIHLA obtains the entire FUV spectrum.
SIHLA: "Follow the Hydrogen" Throughout the Hydrogen Absorption Cell to detect the H lineshape.

The major elements of the Scanning Imaging Spectrograph (SIS) are shown. The SIS is based on extensive spaceflight experience in the design of the Scanning Imaging Reflectograph (SIR), and on the Rowland Circle design of the Imaging Spectrograph (ISS). The SIS Rowland Circle spectrograph enables us to readily include the Lyman-a region in the scene (especially those that are near the upwind flow direction); changes in the absolute calibration; and chromatic aberration [Bertaux et al., 1995, 1997; also Quéemerais, private communication, 2019].

SIHLA Science Goals require an instrument unlike any yet flown for heliospheric science. SIHLA consists of one flight SIS, one engineering model, and a science data product for the heliospheric boundary. The scanning area of the detector at L1) in the system. The SIS Rowland Circle spectrograph enables us to readily include the Lyman-a region in the scene (especially those that are near the upwind flow direction); changes in the absolute calibration; and chromatic aberration [Bertaux et al., 1995, 1997; also Quéemerais, private communication, 2019].

SIHLA SIS corrects the issues with SWAN and, in doing so, enables new science. The SIS, an all-reflection scanning spectrometer, provides unprecedented sensitivities for hydrogen detection by eliminating coma and stray light contributions. The SIS also provides unprecedented spatial and spectral resolution for hydrogen detection by eliminating coma and stray light contributions. The SIS, an all-reflection scanning spectrometer, provides unprecedented sensitivities for hydrogen detection by eliminating coma and stray light contributions. The SIS also provides unprecedented spatial and spectral resolution for hydrogen detection by eliminating coma and stray light contributions.

The science also produces particular data products for the community. These products will be available immediately on the SIHLA mission website.

The SIHLA mission is planned for 12 months, followed by decommissioning after the decommissioning and disposal readiness reviews (DR/DRR). SIHLA will be at the end of Phase A – Risk Reduction. At the time this poster is being created we do not know whether SIHLA will transition to Phase B – Implementation. This excitement powers social media interest in SIHLA and SIHLA features.

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SIHLA (Spatial/Spectral Imaging of Heliospheric Lyman Alpha pronounced as 'Scylla' [e.g. Homer, Odyssey, ~675-725 BC]) is a NASA Mission of Opportunity that has just completed its Phase A study (the Concept Study Report or CSR). The novel aspects of SIHLA are the scope of the science done within a Mission of Opportunity (MoO) budget. The SIHLA projected costs were below the $75M cap with a 31.3% reserve for Phase B-D. The re-purposing of a spectrographic that was part of the DMSP SSUSI line (a copy was flown and NASA TIMED/GUVI and as NASA NEAR/NIS). Risk is extremely low in this Class-D mission with all major elements at least at TRL6 at this time.

SIHLA is a hyperspectral imager; at every point in the sky SIHLA obtains the entire FUV spectrum. This enables SIHLA to detect comets and determine their UV-bright comets as they enter the inner solar system.

3) First detection of response of the Earth’s extended (out to lunar orbit) geocorona to solar/geomagnetic drivers, 4) New data from a spectroscopic imaging imager.

SIHLA will determine whether the heliopause is comet-like or spherical. This is a fundamental question that demands an understanding of the properties of the extended heliosphere at scales below the limit of solar spacecraft.