B.5 HELIOPHYSICS LIVING WITH A STAR SCIENCE

NOTICE: Amended May 20, 2024. This amendment releases final text for this program element, which had been listed as "TBD". Step-1 Proposals are required by August 13, 2024, and Step-2 Proposals are due November 6, 2024.

Step-2 Proposals submitted to this program will be evaluated using a dual-anonymous review process. Proposals must be prepared according to the guidelines in Section 5.3 and in the associated "Guidelines for Anonymous Proposals" document under "Other Documents" on the NSPIRES page for this program element.

In addition to and outside of the 15-page S/T/M section, Step-2 proposals must include: (1) a 2-page "Open Science and Data Management Plan" (OSDMP), see Section 5.3.1, (2) a 2-page statement of the Potential Contribution to the Focused Science Team Effort, see Section 5.3.2.

All proposers are strongly encouraged to use the standard Heliophysics template for Current and Pending Support (for the PI and all Co-Is, regardless of time commitment) and to use the template for the OSDMP. See https://science.nasa.gov/researchers/templates-heliophysic-division-appendix-b-roses-proposals for more details.

1. Scope of Program

The Living With a Star (LWS) Program emphasizes the science necessary to understand those aspects of the coupled Sun-Earth system that affect life and society. The overarching goal of the LWS Program is to provide advances in scientific understanding of this system that can lead to predictive capability of the space environment conditions at Earth, other planetary systems, and in the interplanetary medium. Every year the LWS Science program element solicits Focused Science Topics (FSTs) that address some part of this goal. This year's FSTs are described in Section 1.1 and Sections 2 - 4 below.

Specific LWS program goals are to:

1. Understand how the Sun varies and what drives solar variability.
2. Understand how the Earth and planetary systems respond to dynamic external and internal drivers.
3. Understand how and in what ways dynamic space environments affect human and robotic exploration activities.

Further information on the LWS Program goals and objectives can be found at the LWS website (http://lwstrt.gsfc.nasa.gov). Additional background material can also be found on the LWS website, and in the following documents:

- The LWS TR&T SDT Report https://lwstrt.gsfc.nasa.gov/images/pdf/TRT_SDT_Report.pdf
- The LWS 10-Year Vision Beyond 2015 Report http://lwstrt.gsfc.nasa.gov/images/pdf/LWS_10YrVision_Oct2015_Final.pdf

- The Revised Strategic Science Areas (SSAs) https://lwstrt.gsfc.nasa.gov/assets/docs/lpag/LPAG_EC_report_2019_12_31.pdf
- The National Research Council Decadal Survey Report *Solar and Space Physics: A Science for a Technological Society* http://www.nap.edu/openbook.php?record_id=13060

LWS Science is a component of the Heliophysics Research Program and proposers interested in this program element should read B.1 The Heliophysics Research Program Overview, for Heliophysics-specific requirements. Defaults for all ROSES elements are found in the *ROSES-2024 Summary of Solicitation* and for all NASA solicitations in the *NASA Proposer's Guide.* The order of precedence is the following: This document (B.5) followed by B.1, followed by the ROSES *Summary of Solicitation*, and last the *Proposer's Guide*. Proposers should review all these resources to ensure compliance with Program requirements. See also Section I(g) of the *ROSES-2024 Summary of Solicitation* for a full discussion of order of precedence.

1.1 Solicited Investigations

To be responsive to this program element, proposed investigations must have objectives suitable for one of the three Focused Science Topics (FSTs) listed below:

- FST 1: Connecting Auroral Phenomena with Magnetospheric Phenomena;
- FST 2: Understanding Solar Energetic Particle Transport through the Inner Heliosphere;
- FST 3: Atmospheric Loss and Habitability in the Presence of a Star.

A general overview of FST investigations is given below. Sections 1.2 and 1.3 provide guidance on treatment of uncertainties and data use, respectively, for proposals submitted to any of this year's FSTs. Detailed descriptions of the science goals, objectives, and types of investigations for each FST listed above are given in Sections 2, 3, and 4.

This program element seeks proposals involving a broad range of methodologies (e.g., data analysis, theory, modeling, etc.). To be successful, proposals submitted to one of the three FSTs listed above must identify science questions responsive to that FST's science goals and address them by the proposed work. Individual FST proposals are not required to be a comprehensive scientific study of the entire topic, but instead may address a specific aspect of the topic (e.g., using a particular set of observations, analysis technique, or model) that would contribute to the FST goals and objectives.

For each FST, a Focused Science Team will be formed from the selected individual proposals that each address an aspect of the FST, and together cover the breadth of the FST. To foster the collaborations and coordinate these Focused Science Team research efforts, one of the selected PIs will be invited to serve as the Team Leader for the FST for which they proposed. The Team Leader will organize team meetings and will be responsible for producing a yearly report to the LWS Science program officer describing team activities and progress, in addition to the required annual progress report for their specific award. The other selected PIs will coordinate their research programs with their Team Leader. Recommendations for selection of Team Leaders will be made by the LWS Science Program Officer and final selections will be made by the

Heliophysics Division selecting official. Guidance for the team development process will be provided by the Program Officer after selection of the Team Leader. There is no application to be team leader as part of the proposal submitted to this program element.

Past experience has shown that Focused Science Teams usually need one year to organize team members, followed by another three years to make significant progress on the FST. Thus, the expected duration of FST awards is four (4) years. While proposals with shorter duration are allowed, proposers are encouraged to propose up to four (4) years to ensure maximum overlap between individual contributions to the team efforts.

All proposers to a specific FST must include sufficient travel funds in their budgets to cover two team meetings per year. To leverage travel costs, one meeting per year may be held in conjunction with a major U.S. scientific meeting. Successful teams will participate in a Kickoff Workshop where the selected team members will meet and develop work plans for the anticipated 4-year period of performance based on the requirements of the FST and the composition of the selected team.

1.2 Treatment of Uncertainties

A critical element in enhancing understanding and developing predictive capabilities is the determination of whether the model or data products being developed are accurate and reliable. Consequently, a methodology for verification and validation of results, and quantification of uncertainty, is required as a key component of the proposed research. As mentioned below (Section 6), all proposals must address data and model uncertainty, as mentioned in Section 2.13 of the *NASA Proposer's Guide*, that says proposals must address "sources of error and uncertainties and what effect they may have on the robustness of potential results and conclusions".

1.3 Data Use in the LWS Program

This program element has policies on the use of data in proposals that expand upon and supersede those given in B.1 The Heliophysics Research Program Overview. Data and data products necessary for successful completion of the proposed project must be in a publicly available archive and available at no cost at least thirty (30) days prior to the Step-2 deadline. This applies to both space-based and ground-based observations, as well as any data products derived from them. This 30-day requirement does not apply to data products to be developed as part of a proposed study, only those existing in advance of Step-2 submission. Any questions about whether a data set or data product qualifies as publicly available must be submitted to the LWS Program Officer of the element at least ten (10) days before the Step-1 deadline.

After an award is made, projects may incorporate new data that become available at no cost in a public archive, provided that their use does not alter the goals and objectives of the selected proposal. Any planned changes in the data used must be described in the annual progress report submitted by the PI and approved by the LWS Program Officer.

While the inclusion of useful ground-based observations is allowed, proposals should incorporate relevant space-based observations within the proposed investigation through, e.g., data analysis, model initialization, model validation, or other means.

Regardless of the data types used in the proposed study, the proposal must clearly demonstrate why the proposed data set or data sets are appropriate for addressing the proposed goals and objectives.

2. FST 1: Connecting Auroral Phenomena with Magnetospheric Phenomena

2.1 Topic Description

The auroral region is the gateway for energy and particle input from the solar wind and magnetosphere into the atmosphere. Auroral drivers embody one of the primary ways in which magnetic reconnection couples to the Earth's ionosphere and atmosphere, acting as the indirect means by which the solar wind connects to near-Earth geospace. As such, they also imprint and reveal physical events at the magnetopause and magnetotail as well as the ionosphere. These processes have important implications for ionospheric and thermospheric structure, including formation of localized ionospheric density structures that disturb GNSS signals and satellite operations. Multi-scale high-latitude forcing can also lead to significant changes in thermospheric composition and density at mid- and low-latitudes.

Aurora represent a critical path for transfer and conversion of energy stored in the magnetosphere to the ionosphere-thermosphere system that drives high-latitude ionospheric currents, ionizes the upper atmosphere, heats the ionosphere and upper atmosphere, and powers ionospheric upflows/outflows. In addition, the aurora-related energy extraction and ionospheric upflow/outflow can alter the plasma content and entropy of magnetospheric flux tubes and affect the magnetospheric dynamics. Some types of aurora are associated with enhanced levels of magnetospheric convection during geomagnetic disturbances, such as storms and substorms, while other types of aurora can occur during quiet times and are suggested to be related to magnetospheric instabilities, magnetic reconnection, or the local feedback of ionosphere to magnetospheric energy input. Typical auroral forms spanning from the polar cap to the auroral equatorward boundary include cusp aurora, polar cap arcs, poleward boundary intensifications, streamers, quiet and growth-phase arcs, omega bands, westward traveling surge, giant undulations, beads, and pulsating patches. The recently discovered Strong Thermal Emission Velocity Enhancement (STEVE) emission is another relevant aurora-like phenomenon.

It has been a longstanding challenge to use information on the temporal and spatial evolution of auroral features to understand and interpret the corresponding dynamics in the magnetosphere. Two critical issues stand in the way of realizing this powerful capability: (1) uncertainty in the mapping of the magnetic dynamics between the ionosphere and the magnetosphere; and (2) lack of detailed knowledge about what processes in the magnetosphere produce the various types of aurora.

2.2 FST 1 Science Goals and Objectives

The goals of this FST are to (1) determine what processes in the magnetosphere are responsible for various types of aurora observed in the lower altitudes (i.e., ionospheric E and F regions); (2) to quantitatively assess the energy conversion processes associated with auroral forms and the impact that these auroral processes have on the coupled magnetosphere, ionosphere, and thermosphere system; and (3) to improve existing or establish new high-fidelity mapping between the aurora and the source location in the magnetosphere.

2.3 FST 1 Types of Investigations

Relevant observation sources may include space-based measurements of the magnetosphere, ionosphere, and thermosphere (e.g., SWARM, AMPERE, GOLD, ICON, TIMED, COSMIC, etc.) as well as networks of ground-based instruments (e.g., Global Navigation Satellite System receivers, incoherent scatter radars, ionosondes, Fabry-Perot Interferometers, all-sky imagers, riometers, SuperMAG network, etc.). Implementation strategies could include combinations of data analysis, simulations, and AI/ML techniques.

Potential types of investigations addressing the FST goals and objectives listed in Section 2.2 may include but are not limited to:

- Quantification of feedback pathways between ionosphere-thermosphere system and magnetosphere due to auroral-related processes (e.g., structured conductivity variations).
- Development of new methods, including assimilative and machine learning techniques, that can combine different observations to describe environmental conditions (e.g., the three-dimensional distribution of conductivities, changes in thermospheric composition, dynamics, etc.) across both auroral and subauroral zones.
- Combined data-modeling studies that ingest thermosphere-ionosphere observations into numerical simulations and assess the impact of these observations on simulating magnetosphere–ionosphere coupling processes.
- Investigations exploring the coupling of high- and mid-latitude auroral responses to low latitude conditions during recent strong geomagnetic disturbances.

3. FST 2: Understanding Solar Energetic Particle Transport through the Inner Heliosphere

3.1 Topic Description

An active goal of heliophysics research is to better understand the origins and impacts solar energetic particles (SEPs) that are accelerated by solar flares or at shocks driven by coronal mass ejections (CMEs). Results from past research supported by the LWS program have directly informed several initiatives to improve predictive capabilities for SEP events, including ongoing LWS Strategic Capabilities projects, transition of predictive tools to operational centers through the Space Weather R2O2R program, and the recently established CLEAR Space Weather Center of Excellence. What is now needed are new, innovative investigations that can provide improved physical understanding to inform next-generation predictive capabilities in this area.

Solar energetic particle (SEP) observations at Earth’s orbit reflect a mixture of different physical processes occurring during the particle acceleration and their transport to Earth. Because of this ambiguity, a comprehensive understanding of the physical mechanisms and the relative importance of origin conditions vs. effect of transport processes in determining the characteristics of SEP events and their impact on the coupled geospace system is still lacking. With the advent of distributed observations made by Parker Solar Probe (PSP) and Solar Orbiter (SolO), improved spatial coverage of inner heliosphere observations offers new opportunities to examine the particle transport mechanisms and their effects on SEP events.

In addition to the role that origin conditions play in determining SEP properties at Earth orbit, various heliospheric plasma and magnetic structures, such as coronal mass ejections (CMEs) and associated shock waves, corotating interaction regions (CIRs), magnetic clouds (MCs), and heliospheric current sheets (HCSs) may all cause significant variations in SEP properties (energy spectra, particle composition, temporal evolution, etc.) at different locations in the inner heliosphere. This FST calls for detailed studies of SEP transport processes due to magnetic connectivity, solar wind turbulence, shock waves and coronal or heliospheric structures, with the ultimate goal to improve predictive capabilities of SEP properties throughout the inner heliosphere.

This FST addresses the following key science questions:

- What factors control the observed SEP properties, such as intensity, energy spectra, composition, and temporal evolution?
- How is the SEP evolution influenced by interplanetary transport, magnetic connectivity, and heliospheric structures?
- What is the relative importance of the various transport processes on the SEP properties measured at different latitudinal, longitudinal, and radial locations and at different energies?

This topic is timely because observations from PSP and SolO, in combination with other available SEP measurements and expanding ground-based radio interferometric capabilities, can offer new insight on the generation and transport of SEPs. Such insights are needed to support the upcoming human exploration of the Moon under the Artemis program and the future Mars exploration plans. A clearer understanding of the SEP events would improve the current SEP forecast capability, which is crucial to mitigating the radiation risk in future space exploration. This FST will lead to new data analysis and modeling tools for energetic particle transport that can constrain key aspects of SEP events.

3.2 FST 2 Science Goals and Objectives

The goal of this FST is to evaluate different processes involved in the transport of energetic particles in the inner heliosphere by utilizing new observations, data analysis, and energetic particle modeling. This goal is important for improving current forecast models of SEP events.

Specific objectives of this FST include:

- Demonstration of a capability to quantitatively describe individual SEP events using multiple spacecraft observations and to derive and distinguish different transport effects.
- Advancement of modeling tools and methods for studying and distinguishing different particle transport processes and evaluation of their relative importance.
- Quantitative evaluation of model predictions of the radiation environment in different areas of the solar system against observations for SEP events.

3.3 FST 2 Types of Investigations

Available data sources for this FST include space-based observations of SEPs and related parameters within the inner heliosphere (e.g., PSP, SolO, ACE, GOES, Wind, MAVEN, etc) and ground-based assets, such as radio arrays. Modeling methods appropriate for addressing this topic include particle transport models for predicting the propagation of energetic particles from the Sun to points of interest in the inner heliosphere. Studies that test new theories on energetic particle transport within the inner heliosphere are encouraged. The use of Artificial Intelligence (AI) and Machine Learning (ML) are also encouraged (but not required) in this FST.

Types of investigations addressing the FST goals and objectives listed in Section 3.2 may include but are not limited to:

- Studies of the propagation and distribution of SEPs using multiple spacecraft observations.
- Observation-model comparison for understanding and constraining transport properties (e.g., adiabatic cooling, diffusion, turbulence).
- Investigations into the effects of heliospheric structures (CMEs, shocks, HCSs, MCs, and CIRs) on the transport of energetic particles.

4. FST 3: Atmospheric Loss and Habitability in the Presence of a Star

4.1 Topic Description

The presence of an atmosphere is presumed to be one of the fundamental criteria for sustaining a habitable environment. Atmospheric escape, however, remains a highly complex problem. Despite the wealth of measurements from Earth, Mars, and Venus, we lack a comprehensive understanding of the critical factors that regulate the ultimate loss of an atmosphere to space. The Goldilocks analogy of Venus possessing an overly thick atmosphere, Mars having too little, and Earth featuring the “optimal” amount is not well understood. While estimates of the total escape rates for Mars and Venus (without an intrinsic dipole magnetic field) are on the order of 10^{25} particles per second, estimates for a magnetized Earth are spread over a broader range of 10^{24} to 10^{26} particles per second, primarily due to the complex ionospheric and magnetospheric processes and pathways that arise from the funneling of solar wind energy to the magnetic poles and ultimately drive atmospheric escape. Another critical aspect is the level of ionizing radiation and particle fluxes in the planetary space environment. The origin of stellar eruptions from different types of stars is not well understood given that observations targeting a sample of flaring stars seemed to suggest a lack of CMEs, which have profound implications for exoplanet habitability.

Given the wealth of data from a broad range of sources at Earth (e.g., Cluster, MMS, etc.), Mars (Mars Express, Mars Global Surveyor, and MAVEN), Venus (Pioneer Venus Orbiter, Venus Express, and Akatsuki), Titan (Cassini), Pluto (New Horizons), terrestrial exoplanets (JWST), and the upcoming missions of EscaPADE, Mars 2020, VERITAS and DAVINCI as well as the stellar flare observations from Kepler and TESS, it is timely to seek a quantitative assessment of our current understanding of atmospheric loss and the factors that control it, both from the observational viewpoint and theoretical modeling approaches.

4.2 FST 3 Science Goals and Objectives

The overarching goal of this FST is to explore the atmospheric loss and habitability of a planet (including Earth) through its interaction with the host star. To achieve this goal, investigating various escape mechanisms that lead to the loss of atmosphere to space from both unmagnetized and magnetized planets is necessary. Meanwhile, understanding the impact of stellar extreme ultraviolet (XUV) radiation, stellar winds, stellar activity, and associated energetic particles on planetary atmospheres is necessary to understand the habitability of early Earth and other terrestrial planets in the solar system and beyond. Comparing the processes that drive atmospheric loss to space from planets with strong, weak, or missing magnetic fields could potentially reveal the planetary conditions under which magnetospheric and ionospheric processes dominate over other processes that can result in the loss of planetary atmospheres.

Key science objectives of this FST include:

- Advancing our understanding of how planetary atmospheres are lost to space and the key processes through which the loss occurs.
- Understanding the origin of stellar eruptions and the effects of stellar radiation, winds, magnetic activity, and stellar evolution on the planetary atmospheric escape and habitability.
- Investigating the impact of planetary atmospheric composition, size, obliquity, orbital eccentricity, and the presence of magnetic fields on the planetary atmospheric escape and habitability.

This FST requires a multi-disciplinary team approach to tackle the various aspects of this topic. The successful outcome of proposed investigations would advance capabilities to assess the origin of stellar activity (e.g., flare-CMEs and flares without CMEs) on the Sun and more active, young Sun-like stars as well as G, K, and M-dwarfs. It would also improve understanding of the impact of stellar radiation and winds, magnetic activity (e.g., flares and CMEs), and the associated energetic particles on planetary atmospheric loss to space. Ideally, the results of this FST will inform future efforts to explore planetary habitability beyond our solar system.

4.3 FST 3 Types of Investigations

This FST can leverage current solar models as well as current magnetospheric, ionospheric, and thermospheric models of the Earth, Mars, Venus, and other planets within our solar system to aid in developing sophisticated multi-dimensional multi-fluid models that can be applied to study atmospheric loss to space from terrestrial planets around the Sun and stars of different ages and/or types.

Types of investigations addressing the FST goals and objectives listed in Section 4.2 may include, but are not limited to:

- Utilization of the existing heliophysics models and observational datasets from multiple spacecraft to better quantify atmospheric loss to space from planets of different atmospheric composition, size, obliquity, orbital eccentricity, and magnetic fields through their interactions with the host stars.
- Investigations of solar/stellar impacts (including XUV radiation, winds, and eruptions) on planetary atmospheric loss to space based on analyses of

observational datasets from multiple spacecraft and supplemented with theoretical calculations or first-principle modeling approaches.

- Targeted investigations of processes within the solar corona, solar/stellar wind, of young Sun-like stars and other types of active stars based on inputs from solar and stellar observations (e.g., XUV radiation, magnetic fields, and flare-CMEs).
- Comparative modeling studies of atmospheric loss processes involving Earth, Mars, Venus, and/or exoplanets that may experience more severe or dynamic stellar environments.
- Application of novel modeling approaches and observational strategies (such as data assimilation or AI/ML techniques) to investigate the stellar impact and its evolution on integrated atmospheric loss, atmospheric evolution through time, and planetary habitability.

5. Submission Guidelines

The LWS Science program element review will be executed in a "dual-anonymous" fashion, where the identities of proposers are not explicitly disclosed to the members on the review panel, and the reviewers are not given information about the proposing teams or organizations. Specific instructions on preparing proposals for dual-anonymous review are listed in Section 5.3.

An individual may be Principal Investigator (PI) of one and only one proposal to this program element. The PI (or Science PI) is required to commit at least 20% of their time per year to the investigation.

In addition to the general requirements and restrictions (e.g., in Table 1 of *ROSES-2024* and in B.1 Heliophysics Research Program Overview) this program element has specific compliance constraints for both format (see Sections 5.2.1 and 5.3.1) and content (see Sections 1.2, 1.3, and 5.3). Proposers must include an anonymized Open Science and Data Management Plan in a separate section immediately following the Scientific/Technical/Management portion of this proposal. Proposers are also strongly encouraged to use the standard Heliophysics template for Current and Pending Support for the PI and all Co-Is, regardless of time commitment. These compliance rules ensure fairness and are enforced strictly by the Heliophysics Division. Proposals that are deemed noncompliant will be returned without review or declined following review if violations are found during the evaluation process.

5.1 Two-Step Submission Process

To provide adequate notice to potential reviewers, this program uses a two-step proposal submission process (described in Section IV(b)vii of the *ROSES-2024 Summary of Solicitation*) in which in which a Step-2 proposal can only be submitted if "invited".

In the two-step process a Step-1 proposal is required. Because potential reviewers are solicited based on the Step-1 proposal, investigators may not be added to the proposal team between the Step-1 and Step-2 proposals, unless prior approval is obtained from the LWS Program Officer. The title and broad science goals of the proposal may not be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal.

5.2 Step-1 Proposals

A Step-1 proposal is required and must be submitted electronically by the Step-1 due date given in Tables 2 and 3 of *ROSES-2024*. The Step-1 proposal must be submitted by an Authorized Organizational Representative (AOR) from the PI institution. No budget or other uploaded files are required. Step-1 proposals will be checked for compliance, but they will not be evaluated. Only proposers who submit a Step-1 proposal and who are invited are eligible to submit a Step-2 (full) proposal.

Submission of a Step-1 proposal does not obligate the offerors to submit a Step-2 (full) proposal.

5.2.1 *Step-1 Proposal Content and Format*

The Step-1 proposal is restricted to a 4,000-character Proposal Summary text box on the NSPIRES web interface cover pages. It must include the following information:

- A description of the science goals and objectives to be addressed by the proposal;
- A brief description of the methodology to be used to address the goals and objectives;
- A brief description of the relevance of the proposed study to the scientific objectives of the FST, and the potential contributions of the proposed study to the Focused Science Team's effort.

Since Step-1 proposals may be shared with reviewers as part of the review assignment process, the Proposal Summary information must be anonymous and must not contain any identifying information.

No PDF attachment is required or permitted for Step-1 proposal submission. Proposers will be notified by NSPIRES whether they are invited to submit their Step-2 proposals.

Proposers are strongly encouraged to provide names and contact information of up to five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is. This information can be supplied in response to an NSPIRES cover page question at the time of submission of the Step-1 proposal.

5.2.2 *Step-1 Compliance Criteria*

Step-1 proposals may be declared noncompliant if they fail to meet the submission guidelines, or are outside the scope solicited by this program element. PIs of compliant and responsive proposals will be invited through NSPIRES to submit the associated Step-2 proposal and will be notified through NSPIRES to this effect.

5.3 Step-2 Proposals

A Step-2 (full) proposal must be submitted electronically by the Step-2 due date given in Tables 2 and 3 of *ROSES-2024*. The Step-2 proposal must be submitted by an Authorized Organizational Representative (AOR) from the PI institution. A budget and other specified information is required.

Only proposers who submit a Step-1 proposal and who are invited can submit a Step-2 (full) proposal. Proposers that have received a noncompliance letter in response to their Step-1 proposal are not eligible to submit a Step-2 proposal.

Step-2 Proposals submitted to this program will be evaluated using a dual-anonymous peer review (DAPR) process in which not only are proposers unaware of the identity of the reviewers, the reviewers are not told the identity of the proposers until after the evaluation of the anonymized proposal (see below). The objective of dual-anonymous peer review is to minimize bias in the evaluation of a proposal.

Proposers must follow the instructions in the "Guidelines for Anonymous Proposals" document under "Other Documents" on the NSPIRES page for this program element that explains how to properly prepare the proposal for dual-anonymous peer review.

The forms filled out on the NSPIRES web pages with Proposal Summary, Budget, Proposal Team and Program Specific and Business Data known as the NSPIRES "cover pages" will be partly hidden for the peer reviewers. The Proposal Summary must be anonymized but all other sections of the NSPIRES cover page should be completed as normal and NSPIRES will hide the identifying information from the reviewers. The proposal document must be anonymized, and proposers must upload a separate "Expertise and Resources Not Anonymized" document, that contains all of the personally (and organizational) identifying information.

Review panels will evaluate the anonymized proposals without taking into account the qualifications and capabilities of the proposers. After the evaluation of the anonymized proposal has been finalized for all proposals, panelists will be provided with the "Expertise and Resources Not Anonymized" documents, typically for a subset of proposals that scored highly (depending on the grades and projected selection rates). The panel will then assess the qualifications and capabilities of the team for these proposals and provide comments to NASA.

A summary of the key requirements for anonymized proposals, reproduced from the "Guidelines for Anonymous Proposals" document, is listed below:

Item	Requirement
Proposal Document PDF file	In addition to anonymizing the content, ensure that any PDF bookmarks are anonymous, and the document properties do not reveal names of author or organization.
Science-Technical-Management (S/T/M) section of proposal	The S/T/M section must be anonymized. Omit all names of team members and names of their organizations.
References	References must be in the [1], [2] format.
Open Science and Data Management Plan	The Open Science and Data Management Plan must be anonymized. Two pages are allotted for the Plan. See Section 1.6 of B.1 Heliophysics Research Program Overview
Contribution to the Focused Science Team	The Contribution to the Focused Science Team must be anonymized. Two pages are allotted for this statement. See Section 5.3.2 of this program element.
Biographical Sketches	Do not include in main proposal document. Include in separate "Expertise and Resources Not Anonymized" document.

Table of Personnel and Work Effort	Include in an anonymized fashion (e.g., PI; Co-I#1; Co-I#2) in the main proposal document and in non-anonymized fashion in the separate "Expertise and Resources Not Anonymized" document.
Current and Pending Support	Do not include in main proposal document. Include in separate "Expertise and Resources Not Anonymized" document.
Letters or Statements	All Statements of Commitment and Letters of Support, Feasibility or Endorsement are to be included in the separate "Expertise and Resources Not Anonymized" document.
Redacted Budget and Narrative	Include both redacted budget and narrative in proposal document in an anonymized format. Redacted budgets must not include institutional logos or insignia.
Facilities and Equipment	The Facilities and Equipment Section is to be placed only in the separate "Expertise and Resources Not Anonymized" document. However, the S/T/M Section of the anonymized proposal should address the need for and capabilities of facilities and equipment necessary for the proposed research in an anonymized fashion. Any unique/identifying descriptions of facilities and evidence of access to or affiliation with facilities are to be included in the separate "Expertise and Resources Not Anonymized" document.
Separate "Expertise and Resources Not Anonymized" document	Upload as a separate document in NSPIRES. Choose Attachment Type = "Expertise and Resources Not Anonymized". This document provides a list of all team members, their roles, institutional affiliations, expertise, and contributions to the work. The document should also discuss any specific resources, including facilities and equipment, that are key to completing the proposed work, as well as a summary of work effort. Statements of Current and Pending Support must also be included. Letters of support, e.g., from facilities or archives, must be included in this section.
Total Budget	Upload as a separate document in NSPIRES. Choose Attachment Type = Total Budget. The mandatory total budget file is full and complete with all costs for those at U.S. organizations, including those at government laboratories. It is not redacted or anonymized.
High-End Computing request	Submit optional not-anonymized PDF HEC form as attachment type "Optional HEC request" in NSPIRES. The S/T/M section in the main proposal must state that a HEC request is included and must provide an outline of the computing resources required in an anonymized fashion.

5.3.1 *Step-2 Proposal Format and Content*

All proposals submitted to ROSES must strictly conform to the formatting instructions specified in Section IV(b)ii of the *ROSES-2024 Summary of Solicitation* except where superseded by the requirements in this program element. Proposals that violate these instructions may be returned without review or declined following review if violations are found during the evaluation process.

Proposals are restricted to fifteen (15) pages for the Science/Technical/Management section.

Proposals must include an anonymized Open Science and Data Management Plan (OSDMP), as described in Section 1.6 of [ROSES 2024 B.1, the Heliophysics Research Program Overview](). The OSDMP must be placed in a separate section, not to exceed two (2) pages in length, titled "Open Science and Data Management Plan" immediately following the references and citations for the Science/Technical/Management section. The OSDMP does not count against the 15-page limit for the Science/Technical/Management section. Use of the OSDMP template is strongly encouraged. See https://science.nasa.gov/researchers/templates-heliophysic-division-appendix-b-roses-proposals.

5.3.2 *Required Additional Section in Step-2 Proposal: Potential Contribution to the Focused Science Team*

Proposals submitted to this program element must also address the proposed contribution to the Focused Science Team in a separate anonymized section, not to exceed two (2) pages in length, titled "Potential Contribution to the Focused Science Team Effort" immediately following the OSDMP section of the proposal. Formatting requirements for this section are the same as for the Science/Technical/Management section. This section on Potential Contribution does not count against the 15-page limit for the Science/Technical/Management section. Proposals that fail to address proposed contributions to the Focused Science Team may be declared noncompliant and will typically be returned without review or declined following review if the lack of this section is discovered during the evaluation process.

This Potential Contribution section must summarize the following three topics:

- The relevance of the proposed study to the scientific goals and objectives of the individual FST as outlined in Sections 2.2, 3.2, or 4.2;
- The potential contribution(s) of the proposed study to the broader Focused Science Team's effort;
- Metrics and milestones for determining the successful progress and outcome of the proposed research.

This summary must describe the goals of the proposed project and why they are aligned with the FST goals outlined in Sections 2.2, 3.2, or 4.2. For proposals that address a Type of Investigation that is listed in Sections 2.3, 3.3, or 4.3, this summary must also describe briefly how the proposed investigation addresses one or several of those investigations.

In addition, all proposers are expected to provide a set of metrics that they will use to determine successful progress toward their proposed goals. Proposers must also provide a set of milestones that should indicate the anticipated timing of the major achievements over the course of the proposed study.

The review panel will only consider material in this section when the relevance of the proposal to the Focused Science Team effort is evaluated (see Section 6).

5.3.3 *Step-2 Compliance*

Noncompliant Step-2 proposals will be returned without review or may be declined after review if the noncompliance is found during the evaluation process. Step-2 proposals may be declared noncompliant if:

- The title has substantially changed from that of the Step-1 proposal;
- Investigators have been added since the Step-1 proposal without prior approval of the Program Officer;
- The science goals and objectives have substantially changed from that of the Step-1 proposal;
- The proposal has the same (or essentially the same) team and objectives as a Step-2 (full) proposal currently submitted to or selected by another Heliophysics program in the ROSES-24 announcement;
- The proposal violates the restrictions in Section 1.3 regarding use of data; or
- The proposal violates the formatting instructions in Section 5.3.1.

6. Evaluation Guidelines

Compliant proposals will be evaluated according to three main criteria defined in Appendix D of the *NASA Proposer's Guide*: (1) Intrinsic Merit, (2) Potential Contribution to the Focused Science Team Effort (Relevance), and (3) Cost Reasonableness. The Open Science and Data Management Plan (OSDMP), described in Section 5.3.1 of this program element and Section 1.6 of B.1, the Heliophysics Research Program Overview, will be evaluated as part of Merit. Proposals will be evaluated as specified in the *ROSES-2024 Summary of Solicitation*, with clarifications and additions specific to this program element as listed below.

The evaluation of intrinsic merit will include the following:

- Scientific Merit: Compelling nature and scientific priority of the proposed investigation's science goals and objectives, including the importance of the problem within the broad field of Heliophysics; the unique value of the investigation to make scientific progress in the context of current understanding in the field, and the importance of carrying out the investigation now; and
- Technical Merit: Appropriateness and feasibility of the methodology, including the appropriateness of the selected data, models, and analysis for completing the investigation and the feasibility of the methodology for ensuring scientific success.

Sources of error or uncertainties, and what effect they may have on the robustness of potential results or conclusions, will be evaluated as a methodology issue (intrinsic merit), and the review panel will assign a strength or weakness based on the treatment of these sources as presented in the proposal. Proposers are free to choose any appropriate method of uncertainty analysis or validation of results, but it must be clearly addressed in the body of the proposal. Proposals that fail to address uncertainty will be assigned a Major Weakness in the evaluation and may be considered unselectable.

Based on the above two factors (Scientific and Technical Merit), the evaluation will consider the overall potential science impact and probable success of the investigation and a final adjectival grade for Intrinsic Merit will be assigned.

Relevance will be evaluated separately based solely on information provided in the required section of the proposal entitled “Potential Contribution to the Focused Science Team Effort Contribution” (see Section 5.3.2). The panel will provide feedback to NASA but will not assign a grade and this information will be considered by the Heliophysics selecting official during the selection process.

Evaluation of Cost Reasonableness will include a comparison of the scope of the proposed study to the proposed resources (personnel-time allocated, necessary computer resources, etc.). The panel will provide feedback to SMD but will not assign a grade and this information will be considered by the Heliophysics selecting official during the selection process.

7. Award Types

It is anticipated that awards to non-governmental organizations will be grants or cooperative agreements, as appropriate, rather than contracts which would not be appropriate given the nature of the work solicited. See the *ROSES Summary of Solicitation* Section II(a) Funding and Award Policies for more information.

8. Available Funds

Given the strategic nature of LWS, and the fact that strategically feasible tasks require sufficient investment, it is anticipated that FST proposals will have annual budgets in the range of $200K - $250K per year. This includes fully encumbered Civil Servant labor, where appropriate. It is left to individual PIs to decide whether a strategically feasible award size could be achieved by increased collaborative efforts, greater time commitment of investigators, or a combination of the two. PIs should be cognizant, however, that verification of the level of effort versus the actual work proposed will be part of the review panel process. Given the submission of proposals of adequate number, merit, and range of investigative techniques, NASA anticipates forming teams of approximately 5 to 6 selections for each of the three FST topics. Team Leader activities should not be included in the proposal budget. The Team Leader will receive up to an additional $25,000 per year to support their leader activities, and the Team Leader’s budget will be revised during final award negotiations.

9. Summary of Key Information

Expected annual program budget for new awards	~$4M, see also Section 8, above.
Number of new awards pending adequate proposals of merit	~16, see also Section 8, above.
Maximum duration of awards	4 years
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA

Planning date for start of investigation	No earlier than 6 months after the Step-2 proposal due date.
Page limit for the central Science/Technical/Management section of proposal	15 pages; up to 2 extra pages each for required separate sections describing the Open Science and Data Management Plan (5.3.1) and the Potential Contribution to the Focused Science Team Effort (5.3.2). See also Table 1 of *ROSES-2024* for the default components of a ROSES proposal.
Relevance	Proposals that are relevant to an FST are, by definition, relevant to NASA. See also Section 6.
General information and overview of this solicitation	See the *ROSES-2024 Summary of Solicitation*.
General requirements for content of proposals	See B.1 The Heliophysics Research Program Overview, Section IV and Table 1 of ROSES-2024 and, finally, Section 2 of the *NASA Proposer's Guide*.
Detailed instructions for the submission of proposals	See NSPIRES Online Help, the *NASA Proposer's Guide* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202 479-9376)
Web site for submission of proposals via Grants.gov	https://www.grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH24ZDA001N-LWS
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