A.1.5 SPACE ASTROPHYSICS RESEARCH & ANALYSIS (SARA)

1. Scope of Program

The Space Astrophysics Research and Analysis (SARA) program solicits basic research proposals for investigations that are relevant to NASA's programs in astronomy and astrophysics. The applicable wavelength region in the electromagnetic spectrum is from the radio wavelengths to approximately 100 Å, and below a frequency of ~1 Hz in the gravitational wave spectrum. Laboratory Astrophysics is exempt from wavelength restrictions, as noted below.

This program element has four primary goals: (i) to develop detectors that represent the best possible state-of-the-art detector technology for instruments that may be proposed as candidate experiments for future space flight opportunities; (ii) to develop science investigations whose completion involves the flight of instruments as payloads on suborbital sounding rockets, stratospheric balloons, or longer duration flight opportunities; (iii) to develop supporting technology, perform laboratory research, and/or conduct ground based observations (see below for restrictions) that are directly applicable to space astrophysics missions; and (iv) to investigate topics in gravitational wave astrophysics and space tests of fundamental physical laws (including relativity).

While excellence of proposed research is the primary selection criterion, relevance to NASA missions is a necessary criterion and must be explicitly described in the proposal. Lists of present and future missions of interest are given in Tables 1 and 2 below, which are furnished only as a guide to assessing relevance of proposals for this Program Element. Links to past, present, and future missions are provided through the OSS home page at http://spacescience.nasa.gov.

Special Considerations:

- The Laboratory Astrophysics component of the SARA program includes theoretical investigations in the area of "Atomic and Molecular Astrophysics;" however, proposals to only compile large databases of parameters should be directed to the Applied Information Systems Research Program described in Appendix A.4.2 of this NRA.
- Proposals for ground-based observations will be considered only if they are in direct support of NASA space astrophysics goals, and the proposers are ineligible, by virtue of their institutional affiliation, to receive direct support from the National Science Foundation for ground-based astronomy.

Topics of interest to this SARA program fall into the following six research categories, listed in order of their funding priority:

• *Detector development* – see below for further details;
• *Suborbital* – for example, long-duration balloons, Shuttle based carriers, and sounding rocket-class payloads flown as secondary payloads or other flights of opportunities;
• *Supporting technology studies (longward of 100 Å)* - for example, ultra-light holographic/diffraction grating development, thin films, lightweight composite mirrors, spectrometers, interferometers, and infrared cameras;
•*Laboratory astrophysics (theoretical or experimental for all wavelengths)* - for example, predissociation in diatomic molecules, electron-ion collisions, compilation of transition probability data, measurement of absolute oscillator strengths, spectroscopic studies of PAH's, investigation of carbon clusters, and computation of atomic or molecular parameters;
• *Gravitational wave astrophysics and space tests of fundamental physical laws (including relativity)* - for example, lunar-laser ranging tests of relativity, low frequency gravitational wave astronomy, frame-dragging, geodetic precession, and violations of the equivalence principle (note that theoretical proposals should be submitted to the Astrophysics Theory Program);
• *Ground-based astronomy (longward of 100 Å)* - for example, calibration of supergiants for Hubble Space Telescope and the development of instrumental or observing techniques.

Detector Development Program

The detector development research program solicits proposals that advance the understanding of the fundamental operational aspects of detectors, as well as proposals to develop new types of detectors to the point where they can be proposed as part of instruments in response to future announcements of flight opportunities. Although any detector technology may be proposed to this opportunity, the Next Generation Space Telescope (NGST) project is currently actively supporting detector programs for that mission; therefore, proposals in response to this current NRA for developing detectors specifically to achieve NGST detector sensitivity or performance goals will be given a lower priority.

Considering the currently available technologies for detectors for space astronomy, the greatest emphasis of this solicitation will be for those proposals that address the technological problems associated with achieving some of the following desirable detector attributes (neither in priority order nor exclusive):

- Increasing quantum efficiency;
- Increasing the array format size;
- Increasing the spatial resolution;
- Increasing the dynamic range (including individual detector elements, as well as the collective response of the detector);
- Developing high speed, high resolution, low noise read-out techniques;
- Reducing detector noise;
- Fabrication and formatting techniques;
- Extending wavelength coverage (e.g., operation of submillimeter and radio receivers at high frequency, increasing instantaneous bandwidth, extending mid-IR detectors to operate either passively or cooled at longer wavelengths, or near-IR detectors to shorter wavelengths); and/or
- Developing resistance to effects of operation in space.

Since the environment and constraints of space flight are far stricter than those for ground-based applications, research groups considering development of space detectors must be cognizant of the following characteristics that are highly desirable in reliable, space-quality detection systems: low mass, low sensitivity to particle radiation ("radiation hardness"), low power consumption, compactness, sensitivity at wavelengths shorter than 1100 Å, operation in a vacuum (such that high voltage arcing is minimized), vibration tolerance, ease and robustness of integration with instrumentation, and ease of remote operation, including reduced transient effects and ease of calibration.

New measurement concepts may be proposed, as well as methods to improve the performance of existing detectors. Research into the basic properties of detector systems that could be considered for use in space is mandatory; that is, the purpose of this solicitation is not to support development of detectors that are primarily intended for ground-based astronomy. However, it is understood that observing with ground-based facilities outside the laboratory for newly-developed detectors may be necessary to verify detector or overall system performance; if such an activity is proposed as an integral part of a detector development program, this case must be made clear in the proposal.

Proposers are encouraged to identify potential mechanisms that could facilitate transfer of these detector technologies to other users, including the private sector, for possible application beyond the immediate detector development goals for NASA's programs.

2. Programmatic Information

It is expected that roughly $6.0M will be available in through this NRA for the funding of new projects amongst the six categories: detector development, suborbital, supporting technology, laboratory astrophysics, gravitation and general relativity, and ground-based astronomy. Investigators may propose programs of any size for funding extending up to three years under this solicitation. The actual amount of funding awarded to a particular

program will be determined by the merit of the program and programmatic goals of the Office of Space Science. Funding awards will range from one to three years duration.

Currently sixteen investigations are being funded for suborbital research for a total of $4.1M, thirty one for detector development for a total of $6.2M, and sixty two in the remaining four categories for a total of $5.2M.

While it is recommended that programs proposed span a three-year period, funding limitations may only enable awards of one or two years duration. It is also recognized that a proposed investigation may evolve with time. Accordingly, emphasis in the proposal should be placed upon the first year's effort, with as much detail as possible on any planned second and third year's activities. Proposals for investigations requiring less than a three-year time scale to complete are encouraged, as are those that require a longer time scale to complete, though the latter must undergo subsequent peer reviews every three years. Key projected milestones and accomplishments during each period of the proposed effort should be identified. The proposals selected will be funded on a yearly basis. For multiyear awards, yearly funding allotments to complete a period of performance after the first year require an Annual Progress Report, which should include a summary sufficient to demonstrate that satisfactory progress has been made. If a new proposal for this program element is itself based on a previously funded research effort, the proposal should identify that work and clearly summarize all significant results.

For the suborbital program, budgets are expected to cover complete suborbital investigations, including payload development and construction, instrument calibration, launch, and data analysis. A brief description of the plans for the reduction and analysis of data must be included in the proposal. One goal of the suborbital program is to maintain the continuity of both instrumental expertise and laboratory facilities of research groups specializing in the fields of experimental astrophysics. Therefore, the number of groups that can be supported to fly sounding rockets (and other forms of flight opportunity) is limited and heavily dependent on the funds available to this program. NASA does not carry reserves to accommodate any cost overrun incurred by a particular investigation. Such a situation may entail either descoping the initially proposed investigation, delaying it, or canceling a particular launch date opportunity.

If at all possible, the participation of graduate students in the detector development and suborbital programs is strongly encouraged, especially if it can be concluded within the nominal tenure of graduate training. Therefore, brief details of the educational goals and training of such personnel should be included in the proposal.

IMPORTANT INFORMATION

As discussed in the *Summary of Solicitation* of this NRA, the Office of Space Science (OSS) is now using a single, unified set of instructions for the submission of proposals. This material is contained in the document entitled *NASA Guidebook for Proposers Responding to NASA Research Announcement – 2001* (or *NASA Guidebook for Proposers* for short) that is accessible by opening URL http://research.hq.nasa.gov, and linking through the menu item "Helpful References," or may be directly accessed online at URL http://www.hq.nasa.gov/office/procurement/nraguidebook/. This NRA's Summary of Solicitation also contains the schedule and instructions for the electronic submission of a *Notice of Intent* (NOI) to propose and a proposal's *Cover Page/Proposal Summary*, which now also includes the required *Budget Summary*, and the mailing address for the submission of a proposal.

Questions about this program element may be directed to the Discipline Scientists:

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Table 1. Current and Future NASA Missions Having Objectives for UV, Visible, and Gravitational Astrophysics (see also links through the OSS home page at http://spacescience.nasa.gov)

MISSION	LAUNCH YEAR	REMARKS
• Hubble Space Telescope (HST)	1990	In operation.
Wide Field/Planetary Camera 2 (WF/PC2) 1150–11000Å		In operation.
Space Telescope Imaging Spectrograph (STIS) 1150–11000Å		In operation.
Advanced Camera for Surveys (ACS) 2000-11000Å	2002	Installation scheduled
Cosmic Origins Spectrograph (COS) 1150-3200Å	2004	HST replacement instrument
• Far Ultraviolet Spectroscopic Explorer (FUSE) 800–1200Å	1999	Operational 3 year mission.
• The Galaxy Evolution Explorer (GALEX) 1350 – 3000Å	2002	2-1/3 year mission.
• The Cosmic Hot Interstellar Plasma Spectrometer (CHIPS) 90 – 260Å	2002 .	1 year mission.
• Space Interferometry Mission (SIM)	TBD	Selected for study.
•. Gravity Probe-B (GP-B) -General Relativity	2002	2 year mission
• Laser Interferometer Space Antenna (LISA)	2011	Pre Phase A
• On-going tests of relativity	—	Various current interplanetary spacecraft.

Table 2. Current and Future NASA Missions Having Objectives in Infrared, Submillimeter, and Radio Astrophysics

MISSION	LAUNCH YEAR	REMARKS
• Hubble Space Telescope (HST)	1990	In operation.
Near Infrared Camera and Multi-object Spectrometer (NICMOS) (0.8 – 2.5 microns)	2002	Reactivation planned
• Space Very Long Baseline Interferometry (HALCA)	1996	In operation.
• Submillimeter Wave Astronomy Satellite (SWAS)	1998	In operation.
• Microwave Anisotropy Probe (MAP)	2001	Cosmic microwave background.
• Space Infrared Telescope Facility (SIRTF)	2002	IR Great Observatory.
• Stratospheric Observatory for Infrared Astronomy (SOFIA)	2002	Multipurpose observatory.
• Far Infrared Space Telescope (FIRST)	2007	ESA Cornerstone Mission.
• PLANCK	2007	Cosmic microwave background
• Next Generation Space Telescope (NGST)	2009	Study of Universe at high Z
• Terrestrial Planet Finder	2011	Search for Earth-like planets