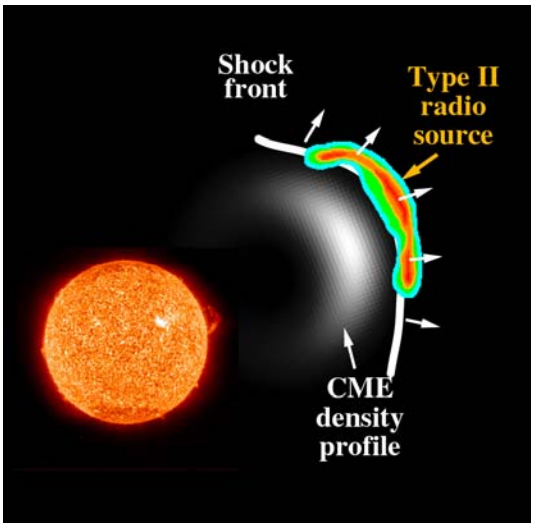
Solar Imaging Radio Array (SIRA):

A Response to the NASA APIO RFI (solicitation # GC-04-06)
Strategic Roadmap Focus Area 9: Explore the Sun-Earth System

SIRA will be the first mission to produce high resolution, low frequency (<15 MHz) radio images of the solar corona and inner heliosphere, thereby providing key data on the heliospheric propagation of coronal mass ejections (CMEs) and resulting space weather. It is a mission with important applications to the NASA Exploration Initiative, as well as a mission with key contributions to the Earth-Sun-Solar System Connection.

Science Objectives:

- Understand CME structure, propagation, & evolution from the Sun to 1AU
- Apply solar radio burst images to mapping of solar wind density structures and magnetic field topology, providing a unique tool for solar wind analysis
- Enhance space weather prediction capabilities using radio tracking of CMEs
- Observe and analyze the global response of Earth's magnetosphere to CMEs and other space-weather-effective events from an external perspective
- Image the low-frequency (< 15 MHz) radio universe at high angular resolution and catalog and understand the objects found therein



Two dimensional radio imaging of the CME-driven shock front provides key data for predicting propagation and space weather effects of CMEs.

Mission Description:

- NASA MIDEX class mission to perform aperture synthesis radio imaging
- Microsat constellation of 12 – 16 identical spacecraft
- Crossed dipole antennas (10 m tip-to-tip) and high dynamic range (>90 db) radio receivers with frequency range ~30 kHz – 15 MHz
- Microsats located on spherical shell with 10 km initial diameter
- Nearly circular distant retrograde orbit (~500,000 km from Earth) or other terrestrial radio interference limiting orbit, such as L1 halo
- Individual microsat communication with ground stations
- Mission life = 2 years (+ 2 years extended mission)
- Lead/managing institution: NASA Goddard Space Flight Center
- Orbital Sciences Corporation selected as spacecraft partner

Measurement Strategy:

- Imaging at ~12 frequencies (corresponding to ~2 solar radii to ~1 AU)
- Frequency spacing and time resolution optimized for solar burst analysis
- Angular resolution of <5 arcmin (anti-sunward) and 30 arcmin (sunward) at 10 MHz

- Daily science data ~38 GB (16 microsats, 2 dipoles, 1% bandwidth, 2-bit sampling)
- Rapid data downlink and processing for space weather prediction (2 ground stations separated in longitude desirable)
- Prompt web-based dissemination of radio burst images & full-sky mapping

Enabling and Enhancing Technology Development:
- Relative intersatellite ranging accuracy of 3 m
- Autonomous constellation operations
- Low mass, low cost components for microsat development

Mission Highlights:

- SIRA responds directly to the Vision for Space Exploration and to the objectives of Sun-Solar System Connections (SSSC) and the Earth-Sun System Division (ESSD) by providing observations that predict the arrival of potentially dangerous and damaging CMEs and associated energetic particles at Earth or other locations in space, as well as leading to an improved scientific understanding of these events.

- SIRA radio imaging is synergistic with white light (coronagraph and all-sky) imaging. The radio and optical emissions are produced by different mechanisms and provide different diagnostics of the medium. Furthermore, the radio data offer an insight into the 3-D source location that is simple to interpret: the radio frequency of emission is directly proportional to the distance from the Sun.

- A successful SIRA mission could lead to the establishment of operational radio imaging constellations for space weather predication.

- SIRA is an excellent pathfinder for multispacecraft constellation missions because of its low cost instrumentation, moderate radiation environment, and simple constellation maintenance requirements.

- SIRA provides an opportunity to conduct "low demand" interferometry in space, because the long wavelengths (20 m to 10 km) observed by SIRA simplify all aspects of interferometry, e.g., the relative separations of the microsats need only be known with an accuracy of 3 meters.

- SIRA is a low cost precursor mission to a lunar-based low frequency radio observatory for solar, space weather, planetary, and astrophysical radio source investigation.

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