



NASA SBIR 2011 Phase I Solicitation

S1.06 Particles and Field Sensors and Instrument Enabling Technologies

Lead Center: GSFC

Participating Center(s): ARC, JPL, JSC, MSFC

Advanced sensors for the detection of elementary particles (atoms, molecules and their ions) and electric and magnetic fields in space and associated instrument technologies are often critical for enabling transformational science from the study of the sun's outer corona, to the solar wind, to the trapped radiation in Earth's and other planetary magnetic fields, and to the atmospheric composition of the planets and their moons. Improvements in particles and fields sensors and associated instrument technologies enable further scientific advancement for upcoming NASA missions such as Solar Orbiter, Solar Probe Plus, ONEP, SEPAT, INCA, CISR, DGC, HMag and planetary exploration missions. Technology developments that result in a reduction in size, mass, power, and cost will enable these missions to proceed. Of interest are advanced magnetometers, electric field booms, ion/atom/molecule detectors, and associated support electronics and materials. Specific areas of interest include:

- Self-calibrating scalar-vector magnetometer for future Earth and space science missions. Performance goals: dynamic range: $\pm 100,000$ nT, accuracy with self-calibration: 1 nT, sensitivity: 5 pT $\sqrt{\text{Hz}}$; $\text{Hz}^{1/2}$ (max), max sensor unit size: 6 x 6 x 12 cm, max sensor mass: 0.6 kg, max electronics unit size: 8 x 13 x 5 cm, max electronics mass: 1 kg, and max power: 5 W operation, 0.5 W standby, including, but not limited to $\sqrt{\text{Hz}}$; sensors on a chip $\sqrt{\text{Hz}}$;
- High-magnetic-field sensor that measures magnetic field magnitudes to 16 Gauss with an accuracy of 1 part in 10⁵.
- Strong, lightweight, thin, compactly-stowed electric field booms possibly using composite materials that deploy sensors to distances of 10-m or more.
- Cooled (-60°C) solid state ion detector capable of operating at a floating potential of -15 kV relative to ground.
- Low noise magnetic materials for advanced magnetometer sensors with performance equal to or better than those in the 6-81.3 Mo-Permalloy family.
- Radiation hardened ASIC spectrum analyzer module that determines mass spectra using fast algorithm deconvolution to produce ion counts for specific ion species.
- Low-cost, low-power, fast-stepping (= 50- μs), high-voltage power supplies 5-15 kV.

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- Low-cost, efficient low-power power supplies (5-10 V).
 - Low-power charge sensitive preamplifiers on a chip.
 - High efficiency (5% or greater) conversion surfaces for low energy neutral atom conversion to ions possibly based on nanotechnology.
 - Miniature low-power, high efficiency, thermionic cathodes, capable of 1-mA electron emission per 100-mW heater power with emission surface area of 1-mm² and expected lifetime of 20,000 hours.
 - Long wire boom (= 50 m) deployment systems for the deployment of very lightweight tethers or antennae on spinning spacecraft.
 - Systems to determine the orthogonality of a deployed electric/magnetic field boom system in flight (for use with three-axis rigid 10-m booms) accurate to 0.10° dynamic.
 - Die-level optical interferometer, micro-sized, for measuring Fabry-Perot plate spacing with 0.1-nm accuracy.
 - Diffractive optics (photon sieves) of 0.1-m aperture or larger with micron-sized outer Fresnel zones for high-resolution EUV imaging.

Developing near-real time data-assimilative models and tools, for both solar quiet and active times, which allow for precise specification and forecasts of the space environment, beginning with solar eruptions and propagation, and including ionospheric electron density specification.