Understanding the connections between the Sun and its planets will allow us to predict the impacts of solar variability on humans, technological systems, and even the presence of life itself. This requires remote and in situ sensing of upper atmospheres and ionospheres, magnetospheres and interfaces with the solar wind, the heliosphere, and the Sun. Improving our knowledge and understanding of these requires accurate in situ measurements of the composition, flow, and thermodynamic state of space plasmas and their interactions with atmospheres, as well as the physics and chemistry of the upper atmosphere and ionosphere systems. Remote sensing of neutral atoms is required for the physics and chemistry of the Sun, the heliosphere, magnetospheres, and planetary atmospheres and ionospheres. Because instrumentation is severely constrained by spacecraft resources, miniaturization, low power consumption, and autonomy are common technological challenges across this entire category of sensors. Specific technologies are sought in the following categories:

**Plasma Remote Sensing** (e.g., neutral atom cameras)

This may involve techniques for high-efficiency and robust imaging of energetic neutral atoms covering any part of the energy spectrum from 1 eV to 100 keV, within resource envelopes less than 5 kg and 5W.

- Miniaturized, radiation-tolerant, autonomous electronic systems for the above, within resource envelopes of 1 - 2 kg and 1 - 2 W.

**In Situ Plasma Sensors**

- Improved techniques for imaging of charged particle (electrons and ions) velocity distributions as well as improvements in mass spectrometers in terms of smaller size or higher mass resolution;
- Improved techniques for the regulation of spacecraft floating potential near the local plasma potential with minimal effects on the ambient plasma and field environment;
- Low power, digital, time-of-flight analyzer chips with sub-nanosecond resolution and multiple channels of parallel processing; and
- Miniaturized, radiation-tolerant, autonomous electronic systems for the above, within resource envelopes of

Page 1 of 2
1 - 2 kg and 1 - 2 W.

**Fields Sensors**

- Improved techniques for measurement of plasma floating potential and DC electric field (and by extension, the plasma drift velocity), especially in the direction parallel to the spin axis of a spinning spacecraft;

- Measurement of the gradient of the electric field in space around a single spacecraft or cluster of spacecraft;

- Improved techniques for the measurement of the gradients (curl) of the magnetic field in space local to a single spacecraft or group of spacecraft;

- Direct measurement of the local electric current density at spatial and time resolutions typical of space plasma structures such as shocks, magnetopauses, and auroral arcs; and

- Miniaturized, radiation-tolerant, and autonomous electronic systems for the above within resource envelopes of 1 - 2 kg and 1 - 2 W.

**Electromagnetic Radiation Sensors**

- Radar sounding and echo imaging of plasma density and field structures from orbiting spacecraft; and

- Miniaturized, radiation-tolerant, and autonomous electronic systems for the above within resource envelopes of 1 - 2 kg and 1 - 2 W.