Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PCG11-01 Room:421 Time:April 28 10:00-10:15

Problems of DC Probe Measurement onBoard Mini/Microsatellite

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DC Langmuir probe is one of the key instruments to study ionosphere by satellite. It needs a counter electrode whose conductive surface are is at least 1000 times larger than that of surface area of the electrode. This requirement is usually fulfilled for large satellites which have been launched so far for ionosphere study. Now we are jumping into an era to use tiny satellites. Then we will encounter serious problems for DC Langmuir probe measurements. Conductive surface area of the satellite becomes much less than 1000 times, or even equal to the surface area of electrode. As a result, measurement of electron density becomes unreliable, because potential of the electrode with respect to the satellite (counter electrode) cannot reach ambient plasma potential where electron density is calculated. For the worst case, DC Langmuir probe is in double probe region, where the maximum current is controlled by ion current. An electronics needs to measure low current. although to measure the low current is not impossible with low frequency response. Another more serious problem is contamination of electrode as well satellite surface. To avoid the effect of contamination, probe bias of DC Langmuir probe need to be swept with about 10 Hz. These two factors make it possible to use DC Langmuir probe, because to measure low current with high frequency is not possible. We review problems which raises for the ionosphere measurement by small satellite, and propose one solution to avoid these problems to accomplish accurate measurements. The data which have been used here are the contribution of three students, G. S. Jiang, W. H. Chen, and Y. W. Hsu, Plasma and Space Science Center, National Cheng Kung University,Taiwan.

Keywords: microsatellite, Dc Langmuir probe, surface area, contamination

PCG11-02 Room:421 Time:April 28 10:15-10:30

Canadian Instrument Participation in Japanese Space Science Mission: A Retrospective Look

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Canada has participated in a number of Japanese space science satellite and sounding rocket missions by contributing scientific instruments and participating in related science investigations since the 1980s, including the Akebono (EXOS-D) and Nozomi (Planet-B) satellite and the SS520-2, S520-23, and S520-26 sounding rocket missions. We review the experience of this participation, including the resulting scientific benefits and the lessons learned.

Keywords: space instrument, space plasma, satellite

PCG11-03 Room:421 Time:April 28 11:00-11:15

Development of Miniaturized Plasma Wave Receiver using ASIC

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Plasma waves are an important physical phenomenon for understanding the electromagnetic environments in space. The plasma wave receiver is roughly divided into two types: a waveform receiver and a spectrum analyzer. Spectrum analyzer provides the frequency spectrums with low noises and high frequency resolution. On the other hand, waveform receiver provides the waveform. Though the waveform has more noise than the spectrum provided by the spectrum analyzer, only the waveform has phase information of a plasma wave. Thus it play a complementary role. However, these plasma wave receivers occupy a large amount of space because of its analog circuits, so a late scientific satellite has only a kind of plasma wave receiver. We have developed miniaturized waveform capture (WFC), a kind of waveform receiver, and sweep frequency analyzer (SFA), a kind of spectrum analyzer, using ASIC (Application Specific Integrated Circuit). We realized 6ch WFC in a chip of 5 mm x 5 mm. We execute experiment expose this chip to radiation. We find that though radiation influence WFC component, especially switched capacitor filter, our WFC fit for the space radiation environment. The SFA has fine frequency resolution, but its time resolution is poor. We propose a new kind of SFA combined with FFT. It has an improved time resolution without losing time resolution. We have developed analog circuits in the new SFA using ASIC technology. Furthermore, we propose the multipoint plasma wave observation system that consisted of some sensor probes using these miniaturized plasma wave receiver. We plan the sounding rocket experiment for performance test of this sensor probe.

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PCG11-04 Room:421 Time:April 28 11:15-11:30

Development of a wide-field X-ray imaging spectrometer for solar system exploration

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We present our development of a wide-field X-ray imaging spectrometer for solar system exploration. In the past decade or so, various types of X-ray emission have been discovered in the solar system (Bhardwaj et al., 2007, Planet. Space, Sci., Ezoe et al., 2011, Adv. Space, Res.). These X-rays are often associated with energetic particles in planetary magnetosphere and neutrals in planetary atmosphere and cometary coma. Therefore, X-ray observations of solar system objects will lead to better understanding of solar system environments and astrophysical phenomena.

For this purpose, we are developing a wide-field X-ray imaging spectrometer for future exploration missions such as GEO-X (Ezoe et al. 2014, Space Sci. Symposium) and JMO (Sasaki et al. 2011, EPSC-DPS). This instrument is composed of an ultra light-weight X-ray telescope and a low-power radiation-hard semiconductor pixel sensor. The telescope covers a wide field of view of ~4 deg in diameter in 0.3–2 keV with the angular resolution of $<$5 arcmin. It uses sidewalls of etched holes through thin 4-inch silicon wafers for X-ray mirrors (Ezoe et al., 2010, Mircosys. Tehc.). The detector covers a wide area of ~20 x 20 mm^2 with a ~300 x 300 um^2 pixel. It is an active pixel sensor developed by MPE and PNsensor (Strueder et al., 2010, SPIE). Compared to X-ray CCDs, this type is more radiation hard and allows higher frame time less than 1 ms. This instrument can satisfy stringent resource constraints in the exploration missions. The mass, size, and power are estimated to be ~10 kg, ~30 cm cubic, and ~10 W, respectively. Multiple units of this instrument are considered for GEO-X to achieve a wider field of view, while one unit will meet science requirements of JMO. In this presentation, we will describe design, fabrication, and performance of the instrument components and future prospects.

Keywords: X-ray, imaging spectroscopy, Earth's magnetosphere, Jupiter, Mars

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PCG11-05 Room:421 Time:April 28 11:30-11:45

ENA Imaging On board the DESTINY Mission

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Energetic Neutral Atom (ENA) imaging is a technique that enables remote imaging of space plasma and neutral clouds. Several current space-borne missions including Cassini, IMAGE, TWINS, Chandrayaan-1, IBEX, and several future missions such as JUICE make use of ENA imaging to investigate magnetospheric plasma acceleration and evolution; structure and acceleration mechanisms in the boundary between the heliosphere and the interstellar medium; and surface and atmosphere interactions (terrestrial upper atmosphere, terrestrial moon, the Galilean moons, and Titan).

Demonstration and Experiment for Space Technology and INterplanetary voYage (DESTINY; See Kawakatsu et al., this conference) is an innovative technology demonstration mission that is being proposed to JAXA with a low-thrust increase of the apogee of an equatorial orbit, followed by a lunar swing-by, and finally an insertion in to a halo orbit around the Sun-Earth L2 point. This trajectory provides a historical opportunity to perform ENA imaging of the two following compelling targets.

- **The terrestrial magnetosphere:** the equatorial vantage point will offer the first compound view of how ions flow out from the polar ionospheres, , plasma stagnation at the sub-solar magnetopause, ion energization in the plasmasheet out to about 20 R_E and the subsequent heating and earthward transport that forms the terrestrial ring current.

- **The boundary between the heliosphere and the interstellar medium:** the NASA/IBEX and Cassini missions have revealed a global pattern and possibly dynamics that are believed to originate from ions charge exchanging in the heliosheath. A multitude of compelling science questions have arisen from the combined analysis of these two data sets that have demonstrated that ENA imaging is perhaps the only tool capable of remotely probing the global structure and acceleration processes in this important region.

The key to observing these targets in a new light that goes beyond previous missions is the ability to image with high angular and energy resolution, with a wide field of view (FOV) that can image large portions of the regions simultaneously. In this presentation we discuss a concept of an ENA camera to perform imaging from DESTINY. The ENA camera design is capable of imaging ENAs in the $\leq$1keV - 100 keV range with an angular resolution down to 2 degrees and an energy resolution down to 20%. The current design has a FOV of 120x90 degrees, which dramatically increases the duty cycle over single-telescope detectors on spinning platforms.

PCG11-06 Room:421 Time:April 28 11:45-12:00

A compact, broad-beam, low-energy, LED-based, UV photoelectron source for the calibration of plasma analysers.

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Electrostatic electron analyser instruments are used to make in-situ measurements of space plasmas and are typically designed to detect electrons with energies from a few eV to a few tens of keV. To make optimal use of such instruments, a complete calibration is performed in a laboratory vacuum chamber before flight. An electron source and a moveable stage are used so that the instrument response can be characterised at every relevant electron energy and beam direction. For an ideal calibration, the source should be a uniform, collimated electron beam of controllable energy and flux, which is sufficiently broad in diameter to cover the entrance aperture of the electron analyser instrument being tested.

Various sources are used for such purposes, including radioactive beta-emitters and thermionic emission guns — although the former have fixed flux and are broad-band in energy, and the latter are expensive and produce only a narrow beam with limited energy ranges and limited dynamical control. To produce a broad, uniform, highly-controllable, long-lifetime, monoenergetic beam, UV photoelectron sources are generally preferable. These consist of a UV light source which illuminates a photocathode causing it to release photoelectrons. These electrons, which are released with negligible kinetic energy, are accelerated toward a high transmission grid by an electric field. The source can thus be as wide as the grid and the photocathode, as spatially uniform as the light that falls on the photocathode, and as collimated and monoenergetic as the photocathode and grid are flat and parallel (and thus the E field uniform). The electron flux can be adjusted by adjusting the UV lamp intensity, and the electron energy can be varied by adjusting the strength of the grid-photocathode E-field.

Traditionally the UV photons are created using gas discharge lamps (e.g. mercury, xenon, deuterium), however these typically have poor dynamical control, can create large amounts of background light and are bulky and inefficient. In recent years however, advances in solid-state technologies have enabled increasingly powerful, efficient and affordable LEDs of various UV wavelengths. Accordingly this has enabled compact, low-power, UV-stimulated electron sources that can have intensities that vary between 10 to 10^{-9} electrons cm^{-2} s^{-1}.

To meet the requirements for calibrating the electron analysers for the SCOPE (cross Scale COupling in Plasma universE) mission, a 9cm beam diameter, UV photoelectron source of this nature has been built and is being tested. Weighing approximately 1.5kg (excluding power supplies) and consisting of rugged, low cost components it can be mounted inside the vacuum chamber with great flexibility, including on a motorised translation stage.

The SCOPE mission requires several FESA (Fast Electron energy Spectrum Analyser) instruments for 10eV to 30keV electrons and several EISA (Electron Ion Spectrum Analyser) instruments for 10eV to 20keV electrons and ions. The first duty of the new electron source is the testing of prototype developments for the EISA instrument: namely measuring the electron transmission properties of carbon foil and assessing the secondary electron emission performance of candidate dynode materials

Keywords: Electron energy analyzer, Plasma spectrometer, Particle source, Ultra-violet photoelectron, Calibration, UV LED

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PCG11-07 Room:421 Time:April 28 12:00-12:15

Characterization of Exoplanets with High Contrast Instruments

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Small exoplanets in the habitable zone (HZ) have been recently discovered by Kepler spacecraft and by ground-based radial velocity surveys. Now one of most interesting issues in this field is how to characterize them. In this presentation, I review our approaches to develop the instruments of direct imaging for the Thirty Meter Telescope (TMT) and other ground-based telescopes. These instruments aim to detect exoplanets in the HZ around late-type stars. I show that the search for the oxygen 1.27 micron bands as a biomarker is promising with the ground-based direct imaging (Kawahara+12 ApJ). I also show that the combination of extreme adaptive optics and coronaraphs for the direct imaging is also valuable for other characterization of exoplanets, for instance, for detection of exoplanetary molecules in close-in planets.

Keywords: exoplanets, terrestrial planets, direct imaging, biomarker

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PCG11-08 Room:421 Time:April 28 12:15-12:30

Development of geocoronal Hydrogen Lyman Alpha Imaging CAmera (LAICA)

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Hydrogen and helium atoms are the main constituents of the outermost region of the earth's atmosphere. These atoms resonantly scatter solar ultraviolet radiation causing an ultraviolet glow in this region, called geocorona. Hydrogen Lyman alpha radiation (121.567 nm) is the brightest. To date, various observations of the geocorona have been made. The geocorona comprises three main particle populations: ballistic, escaping, and satellite. Escaping particles are present at all altitudes, and they become particularly dominant at higher altitudes. In previous observations, the geocorona was identified to extend to an altitude of about 20R$_E$. The geocoronal distribution reveals asymmetries from day to night, dawn to dusk, and north to south. Recently, abrupt temporary increases (from 6% to 17%) in the total number of hydrogen atoms in the spherical shell from a geocentric distance of 3R$_E$ to 8R$_E$ have been recorded during several observed geomagnetic storms.

Past exploration of the geocorona has mainly been obtained from earth orbiters. Therefore, several low altitude (~8R$_E$) observations have been made. On the other hand, in order to obtain the geocoronal distribution at high altitude, it is necessary to observe the geocorona from the outside in. However, there have been very few such observations (only Mariner 5, Apollo 16, and Nozomi). Among them, only Apollo 16 obtained an image. However, the observational FOV was about 10R$_E$.

In this study, we are developing a LAICA (geocoronal hydrogen Lyman Alpha Imaging CAmera) which will go onboard the very small deep space explorer PROCYON that will escape the earth and navigate interplanetary space. From such an explorer, our equipment can perform wide FOV (more than 25R$_E$) imaging of the geocoronal distribution. The first observation will be conducted one week after the launch for a period of one or two weeks. Subsequently, observations will continue for about three months. These observations will be conducted in higher temporal resolutions than that obtained from earth orbiters. The prototype of the LAICA has now been manufactured for testing and verification. And the flight model will have been completed by May. This presentation will show the development status.

Keywords: geocorona, Lyman alpha line, exosphere, earth's atmosphere