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PCG11-01 会場:421 時間:4 月 28 日 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.

キーワード: microsatellite, Dc Langmuir probe, surface area, contamination
Keywords: microsatellite, Dc Langmuir probe, surface area, contamination

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PCG11-02 会場:421 時間:4 月 28 日 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.

キーワード: space instrument, space plasma, satellite
Keywords: space instrument, space plasma, satellite

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PCG11-03 会場:421 時間:4 月 28 日 11:00-11:15

ASIC を用いた小型プラズマ波動受信器の開発
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 会場:421 時間:4 月 28 日 11:15-11:30

太陽系探査を目指す広視野 X 線撮像分光装置の開発
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 mmˆ2 with a ˜300 x 300 umˆ2 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.

キーワード: X 線, 撮像分光, 地球磁気圏, 木星, 火星
Keywords: X-ray, imaging spectroscopy, Earth’s magnetosphere, Jupiter, Mars

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PCG11-05 会場:421 時間:4 月 28 日 11:30-11:45

ENA Imaging On board the DESTINY Mission
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.

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PCG11-06 会場:421 時間:4月28日 11:45-12:00

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

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

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

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高コントラスト装置を用いた太陽系外惑星キャラクタリゼーション
Characterization of Exoplanets with High Contrast Instruments

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ケプラー衛星や地上RV探査によりハビタブルゾーン内の小型系外惑星が多数見つかってきた。この分野における一つの目標として、このような惑星の特徴をいかに知るかということがある。本発表では、我々の30m望遠鏡やその他の望遠鏡搭載を目指した装置開発へのアプローチを概説する。これらの装置では、地上から晩期星周りのハビタブルゾーン内惑星の直接撮像を狙っている。地上直接撮像観測においては酸素1.27ミクロン線によるバイオマーカー探査が有効であることを示す (Kawahara+12)。またこのような直接撮像装置に必要な極限補償光学とコロナグラフの組み合わせが、他の系外惑星キャラクタリゼーション、特に、クロースイン惑星における大気分子種の検出にも有効であることも紹介したい。

キーワード: 系外惑星, 地球型惑星, 直接撮像, バイオマーカー
Keywords: exoplanets, terrestrial planets, direct imaging, biomarker

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PCG11-08 会場:421 時間:4 月 28 日 12:15-12:30

ジオコロナ撮像装置 LAICA の開発
Development of geocoronal Hydrogen Lyman Alpha Imaging CAmera (LAICA)

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地球大気圏の最も外側で大気が無衝突となる、密度が希薄な領域のことを外気圏と呼ぶ。外気圏における主な構成原子は水素とヘリウムであるが、これらの原子は特定の太陽紫外放射を選択的に散乱しており、地球全体を包む紫外グローを形成することからジオコロナと呼ばれている。その中でも水素ライマン α 線 (121.567nm) が最も明るく、これまでに様々な観測が行われてきた。

ジオコロナを構成する原子の軌道は、弾道軌道、地球を周回する軌道、地球重力圏を脱出する軌道の 3 種類ある。特に高高度では地球重力圏を脱出する軌道を持つ原子が支配的となり、過去の観測では高度約 $20R_E$ にまで及ぶジオコロナが確認されている。ジオコロナの空間分布の特徴として、外気圏水素が反太陽方向に引き伸ばされ、密度が太陽方向よりも高くなるようなジオテイルと呼ばれる構造や、昼夜、南北、朝夕の非対称性などが知られている。最近では、3~$8R_E$ までの範囲に存在する水素原子数が磁気嵐に伴って 6~17%程度増加するという現象が確認されたが、その原因は未解明である。

過去の計画では地球周回衛星からの観測が主で、ジオコロナの広がりに対して低高度 (~$8R_E$) の観測が多く行われてきた。一方、高高度のジオコロナ分布を捉えるためには地球から十分離れ、ジオコロナの外から観測を行う必要があるが、観測例は極めて少なく、Mariner 5、Apollo 16、のぞみの 3 例だけである。その中でも 2 次元イメージャを搭載し、撮像を行ったのは Apollo 16 だけであるが、観測視野は $10R_E$ 程度までとなっている。

そこで本研究では地球を脱出して惑星間空間を航行するような軌道に乗る、超小型深宇宙探査機 PROCYON に搭載予定のジオコロナ撮像装置 LAICA の開発を行っている。月軌道以遠に達する探査機からであれば、地球周回衛星よりも広い観測視野 ($25R_E$ 以上) でジオコロナの全球分布を捉えることが可能となる。目標としては、打ち上げ後 1~2 週間で観測を行い、広範囲のジオコロナ分布を撮像する。また、打ち上げ後 10 日から 3 か月程度の期間で、地球周回衛星に比べて高い時間分解能 (1 時間程度) での観測を行い、高高度のジオコロナ分布の変動を捉える。現在は試作機の製作を進め、振動・衝撃試験などを実施している。フライトモデルも 2014 年 5 月には完成予定である。本発表では装置の開発状況について報告する。

キーワード: ジオコロナ, ライマン α 線, 外気圏, 地球大気
Keywords: geocorona, Lyman alpha line, exosphere, earth's atmosphere