Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-01 会場:202 時間:5 月 23 日 09:00-09:30

Sprint-B/ERG 衛星計画
Sprint-B/ERG satellite project

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The ERG (Energization and Radiation in Geospace) is a geospace exploration mission in Japan for the solar maximum and subsequent declining phase of solar cycle 24. The mission is especially focusing on the relativistic electron acceleration mechanism in the context of the cross-energy coupling via wave-particle interactions as well as the dynamics of space storms. The interplay among different plasma/particle populations of the inner magnetosphere; plasmasphere, ring current/plasma sheet, and radiation belts is a key to understand the energetic particle accelerations. The cross-regional coupling such as magnetosphere-ionosphere via FAC and the potential electric fields causes the spontaneous variations of the ambient fields.

The ERG project consists of the satellite observation team, the ground-based observation team, and integrated-data analysis/simulation team, as well as the science working team and the project science team. The SPRINT-B/ERG satellite of ISAS/JAXA will be launched into inner magnetosphere in FY2014-2015. The comprehensive instruments for plasma/particles, field and waves are installed in the SPRING-B/ERG satellite to elucidate the electron acceleration processes. The newly developed system will directly measure the flow of the Poynting flux between particles and waves in the wave-particle interactions. In this talk, we will present the current status of the ERG project and possible collaborations with other geospace satellite missions.

キーワード: 小型科学衛星, ジオスペース探査
Keywords: Small Science Satellite, Geospace Exploration

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-02 会場:202 時間:5 月 23 日 09:30-10:00

Development of a Low-Energy Electron Instrument LEP-e for the ERG Mission
Development of a Low-Energy Electron Instrument LEP-e for the ERG Mission

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Plasma and Space Science Center (PSSC) at National Cheng Kung University in Taiwan is now developing a low-energy electron instrument for Japan's radiation belts observation mission ERG (Energization and Radiation in Geospace). The instrument consists of an electrostatic energy analyzer with multi-channel plates (MCP) and electronics. The energy analyzer is of the top-hat type, and measures radiation belt electrons from approximately 10 eV to 20 keV. The analyzer's design was studied by numerical particle tracing simulations to achieve good electron measurement performance. The challenge in this development is how to suppress effects due to harsh background radiations in the inner magnetosphere. As a measure against radiation, the analyzer employs 6-mm aluminum shields to reduce radiation penetration to the MCP. Based on GEANT4 radiation simulations with the AE-8/AP-8 radiation model, ˜1000 counts/sec of the radiation noise can be received by the MCP. To reduce the radiation effects, a channel is placed for measuring the background noise counts. In the presentation, the electron observation performance and the radiation effects will be discussed.

キーワード: Top-Hat Analyzer, Electron Energy Spectrum, Electron Pitch Angle Distribution, radiation belt
Keywords: Top-Hat Analyzer, Electron Energy Spectrum, Electron Pitch Angle Distribution, radiation belt

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-03 会場:202 時間:5 月 23 日 10:00-10:15

SPRINT-B(ERG) 衛星に搭載する中間エネルギーイオン質量分析器の性能試験
Performance tests of medium-energy ion mass spectrometer developed for SPRINT-B (ERG)

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We have been developing a medium-energy ion analyser for the radiation belt mission SPRINT-B (ERG). This instrument is comprised of an electrostatic analyser, time-of-flight (TOF) mass spectrometer, and solid state detectors, hence it can measure energy, mass and charge state of 10-180 keV/q ions. It provides the significant information of flux and pitch angle distribution of ring current core components, which is essential for the understanding of the radiation belt dynamics. One of the important issues for particle measurements in the inner magnetosphere is the mitigation of the background noise caused by the radiation belt particles. When the penetrating high-energy electrons (greater than MeV) and protons (greater than 10 MeV) hit detectors in the TOF unit, they produce spurious signals. Secondary particles (electrons and gamma rays) also cause a significant background. Therefore we have designed a TOF unit that is especially suitable for the radiation belt observations in terms of the small detection areas (note that the background count rate is less for the smaller detector areas). Through experiments in a laboratory we have confirmed expected performance on TOF profiles expected from numerical simulations.

Japan Geoscience Union Meeting 2012
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PCG14-04 会場:202 時間:5 月 23 日 10:15-10:30

内部磁気圏での直接探査を目的とした 0.01-25keV/q イオン質量分析器の開発
Development of 0.01-25keV/q ion mass spectrometer for inner magnetospheric reserach

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Measurements of plasma partciles with energies lower than 100keV is not easy in the terrestrial magnetosphere, since fluxes of high-energy particles are large. High-energy particles can penetrate through, or kick out the secondary particles when they hit materials. This means they can be detected by a detector inside an instrument without any analysis, namely, noise. We are developping an ion energy-mass spectrometer with energy range of 0.01-25keV/q for terrestrical inner magnetosphere. In order to reduce the noise generated by the high-energy particles, we apply a time-of-flight (TOF) technique. In addition, we try to minimize size of the detector.

We will discuss how an instrument in the current design can survive under severe environment like terrestrial inner magnetosphere.

キーワード: プラズマ粒子計測器, 内部磁気圏, ERG
Keywords: plasma particle instrument, terrestrial inner magnetosphere, ERG

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-05 会場:202 時間:5 月 23 日 10:45-11:15

The ESA-led JUpiter ICy moon Explorer mission: a sophisticated instrumentation in an intense radiation environment

The ESA-led JUpiter ICy moon Explorer mission: a sophisticated instrumentation in an intense radiation environment

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The JUICE (Jupiter ICy moon Explorer) mission is one of the three candidates for the first ESA Cosmic Vision 2015/2025 L-class mission slot, with a foreseen launch in 2022. The final selection will be known in April 2012. JUICE will carry out an in-depth study of the Jovian system and its four largest satellites, with particular emphasis on Ganymede and Europa. It will conduct unprecedented detailed studies of Jupiter and its magnetosphere, the diversity of the Galilean satellites, the physical characteristics, composition and geology of their surfaces. A model payload of 11 instruments addressing most of JUICE science goals has been studied for the spacecraft. The studied model payload consists of a remote sensing package, a geophysical package, and an in situ package. We will first review the mission science objectives and enabling instrumentation. We will then make use of the charged particle package in order to illustrate some of the main mission challenges related to the intense radiation environment of Jupiter.

キーワード: Jupiter, instrumentation, mission, radiation, particle package
Keywords: Jupiter, instrumentation, mission, radiation, particle package

Japan Geoscience Union Meeting 2012
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PCG14-06 会場:202 時間:5 月 23 日 11:15-11:30

BepiColombo 日欧共同水星探査ミッション：MMO プロジェクト最新状況報告
BepiColombo Euro-Japan Joint mission to Mercury: MMO Project Status update

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紀元前から知られる水星は、「太陽に近い灼熱環境」と「軌道投入に要する多大な燃料」から周回探査は困難であり、昨年 3 月からの米国 MESSENGER による観測が初めてのものである。過去の探査から、この小さな惑星にはあり得ないと考えられていた磁場と磁気圏活動の予想外の発見をもたらしたが、その究明は未だこれからの課題となっている。「ベピ・コロンボ（BepiColombo）」は、欧州宇宙機関（以下、ESA）との国際分担・協力によりこの惑星の磁場、磁気圏、内部、表層を初めて多角的・総合的に観測しようとするプロジェクトである。固有磁場と磁気圏を持つ地球型惑星は地球と水星だけで、初の水星の詳細探査＝「初の惑星磁場・磁気圏の詳細比較」は、「惑星の磁場・磁気圏の普遍性と特異性」 の知見に大きな飛躍をもたらす。また、磁場の存在と関係すると見られる巨大な中心核など水星の特異な内部・表層の全球観測は、太陽系形成、特に「地球型惑星の起源と進化」の解明に貢献する。

本計画は、観測目標に最適化された 2 つの周回探査機、すなわち表面・内部の観測に最適化された「水星表面探査機 (MPO)」（３軸制御、低高度極軌道)、磁場・磁気圏の観測に最適化された「水星磁気圏探査機 (MMO)」（スピン制御、楕円極軌道）から構成される。ISAS ／ JAXA は、日本の得意分野である磁場・磁気圏の観測を主目標とする MMO 探査機の開発と水星周回軌道における運用を担当し、ESA が残りの全て、すなわち、打ち上げから惑星間空間の巡航、水星周回軌道への投入、MPO の開発と運用を担当する。

両探査機に搭載する数々の科学観測装置は、2004 年の搭載機器選定以降開発は着々と進行し、日本側の詳細設計審査は平成 23 年 11 月に終了し、ESA 側の詳細設計審査は平成 24 年 7 月に予定されている。JAXA の開発する MMO は本年 1 月に電気・機械インターフェース試験が終了し、本年 6 月末から開始される総合試験までの間に搭載各機器の環境試験並びに最終のキャリブレーションが行われる。また、MMO 構造モデルは昨年 11 月に ESA/ESTEC へ輸送され、今年行われる全体構造モデル試験に備えている。

水星到着後の観測は、選ばれた装置開発チームに留まらず、広く日欧研究者で構成する「BepiColombo 科学ワーキングチーム」(年 1 回程度開催) で立案・実施される。本講演では、これら科学観測に関連した状況及び、日本側が製作を担当する MMO について最新状況を報告する。

キーワード: 水星, 惑星探査, 国際協力
Keywords: Mercury, Planetary Exploration, International Collaboration

Japan Geoscience Union Meeting 2012
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PCG14-07 会場:202 時間:5 月 23 日 11:30-11:45

太陽発電衛星における大電力マイクロ波と電離層プラズマとの相互作用に関する宇宙実験の基礎検討
Space Experiment on Interaction between High Power Microwave and Ionospheric Plasma for Solar Power Satellite

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The Space Solar Power System (SSPS) which converts solar energy into electricity in space, and transmits energy using microwave from space to the ground is a promising candidate for a clean and sustainable energy system. The first solar power satellite (SPS) concept was proposed by Dr. P.E.Glaser in 1968. R & D activities on the SPS have been carried out in US, Japan and Europe. Some key technologies require space experiments in order to realize the SPS. Especially, Wireless power transmission (WPT) is inherent technology of the SPS, and WPT demonstrations on the ground and in space have been performed in Japan. Two rocket experiments, MINIX in 1983 and ISY-METS in 1993 were performed by Kyoto University and ISAS in order to study nonlinear interactions of the high power microwave in the space plasma environment and to demonstrate microwave power transmission. However higher-accuracy evaluation of the effect of the microwave against the ionospheric region is required because the experiments of the sounding rocket are limited in time and mass resources. Microwaves interact with ionospheric plasma. Plasma density gradient and its variation will results the phase shift of the microwave and degradation of the accuracy of the microwave beam pointing. Also, injection of the high power microwave into plasma will cause a change in plasma distribution of ionospheric region or a plasma hole that will affect on communications. There are some interaction mechanism between ionospheric plasma and high power microwave. Plasma heating by the microwave will cause a decreasing of the plasma density and thermal self focusing of the microwave beam. Several potential non-linear interactions between ionosphere and microwave have been identified. These include parametric instability excitation, electron thermal runaway in the lower ionosphere and thermal self-focusing of the microwave beam by the ponderomotive force. Microwave power density around ionospheric region is designed around several hundred W/m2 for the future commercial base SPS. These effects should be confirmed by the space experiments. We are considering a space experiment on the WPT from space to the ground and on the interaction between high power microwave and ionospheric plasma using a small scientific satellite. The total microwave power radiated from the power transmission panel is 0.95 kW for a single antenna panel configuration. This level of microwave power injection will generate a power density above 1000 W/m2 within 50 m, and 100 W/m2 within 100 m in the ionosphere. Effects of interaction between high power microwaves and plasma in ionosphere can be measured. We plan to measure the electron temperature, the electron density and excited waves under the microwave irradiated conditions using plasma probes, wave receiver or some observation equipments. We would like to discuss the on-board instrumentations for the plasma and waves measurement in ionosphere.

キーワード: 太陽発電衛星, マイクロ波, 無線送電, 電離層, プラズマ
Keywords: Solar Power Satellite, Microwave, WPT, plasma, ionosphere

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-08 会場:202 時間:5 月 23 日 11:45-12:00

Development of High Resolution Magnetometers for Space Plasma Study at SPDL

Development of High Resolution Magnetometers for Space Plasma Study at SPDL

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Space plasma has the unique property of being highly collisionless and thus conducting. As a result, the magnetic field is highly perturbed due to the complex motion of charged particles. Measurement of high resolution magnetic field is very important for providing information on the physics of small spatial and temporal scales of collective plasma which cannot be achieved by particle instruments. Satellite Payload Development Laboratory (SPDL) at National Central University was founded in 2002 with the goal of developing high resolution space instruments for in-situ exploration and study of magnetspheric and collisionless space plasma by space science major students. In this talk we present the achievement and recent progress on the development of high resolution magnetometers by the efforts of SPDL members.

キーワード: Magnetometer, Space Plasma
Keywords: Magnetometer, Space Plasma

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-09 会場:202 時間:5 月 23 日 13:45-14:15

Tiny magnetic field measurement system onboard satellites by using an ASIC chip

Tiny magnetic field measurement system onboard satellites by using an ASIC chip

Werner Magnes[1*], Hans Hauer[2], Aris Valavanoglou[1], Matthias Oberst[2], Harald Neubauer[2], Irmgard Jernej[1], Christian Hagen[1], Wolfgang Baumjohann[1]
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Scientific instruments for space applications are required to reduce their resource requirements, such as volume, mass and power while at the same time achieving at least the same performance as conventional instruments. So it is important that especially the instrument front ends and readout units undergo miniaturization.

A front-end ASIC (Application Specific Integrated Circuit) for magnetic field sensors based on the fluxgate principle (Magnetometer Front-end ASIC, MFA) has been developed that reduces the required power for the active readout electronics by a factor of 10 as well as the area needed on a printed circuit board by a factor of 3-4 compared to magnetic field instruments e.g. aboard Venus Express (ESA).

The concept of the MFA is based on a combination of the readout electronics of a conventional fluxgate magnetometer with the control loop of a delta-sigma modulator in order to get an optimized signal-to-noise ratio with a reasonable oversampling factor. The analog part of the MFA contains altogether four 2-2 cascaded sigma-delta modulators. Three of those modulators are having the fluxgate sensor in their control loops for a direct analog-to-digital conversion of the sensor output. The fourth modulator is unmodified and connected to the output of an eight-to-one multiplexer for housekeeping measurements (e.g. temperatures of MFA and fluxgate sensor). The single-bit outputs of the cascaded modulators are processed by a digital tuning logic for generating a fourth-order noise shaped and digitized output signal. The digital part includes primary (128Hz output) and secondary decimation filter stages (2, 4, 8, to 128Hz output) as well as a serial synchronous interface (data are transmitted with 24 bit resolution). The chip area (0.35um CMOS from austriamicrosystems) is about 20mmˆ2 and the total power consumption is 60mW (drive power for the fluxgate sensor is not included).

The achieved performance and radiation robustness can be summarized with THD $>$ 95dB, SNDR in field mode $>$ 85dB, offset stability $<$ 10pT/degC and $<$ 0.2nT/100h and TID $>$ 300krad. A first space magnetometer equipped with the MFA will fly aboard a 4-satellite NASA mission called Magnetospheric Multiscale (launch in 2014).

キーワード: Magnetometer, Miniaturization, Fluxgate, Magnetic Field
Keywords: Magnetometer, Miniaturization, Fluxgate, Magnetic Field

Japan Geoscience Union Meeting 2012
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PCG14-10 会場:202 時間:5 月 23 日 14:15-14:30

アナログ専用集積回路による小型プラズマ波動受信器の開発
Development of Miniaturized Plasma Wave Receiver using analog ASIC

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FUKUHARA, Hajime[1*], OKADA, Satoshi[1], Hiromune Ishii[1], KOJIMA, Hirotsugu[1], Hiroshi Yamakawa[1]

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Since space is filled with collisionless plasmas, kinetic energies of plasma particles are exchanged via electric and magnetic fields, so-called plasma waves. The plasma waves have been observed a number of scientific spacecraft with plasma wave receivers. The plasma wave receivers are classified into two types, spectrum receivers, and waveform receivers. The spectrum receivers provide an overview of physical processes in which the plasma waves are excited, grown, and dissipated. The waveform receivers give not only amplitude but also phase of the plasma waves. Phase information between the plasma waves and plasma particle is essential in wave-particle interactions. It is important for understanding physical processes to combine both kinds of data of spectra and waveforms. Since the plasma waves have various intensities in wide-band frequency range, from DC to tens of MHz, the onboard instruments for the plasma wave observation are required to have low noise, high sensitivity, and wide dynamic range in wide-band. The required performances lead to increase the weight budget of the analog part of the instrument since discrete electronics devices and integrated circuits are usually used to implement the instruments. We have developed dedicated chip which can drastically decrease weight budget of the plasma wave instruments for multi-point observation and deep space exploration missions. It is also significant that manufacturing a number of instruments with the same performance becomes easy. In this paper, we demonstrate the miniaturized plasma wave receiver using ASIC (Application Specific Integrated Circuit) technology. The ASIC is a LSI (Large Scale Integrated circuit) for a particular purpose, is commonly developed for a consumer electronics products. For the spectrum receiver, we develop a double super heterodyne receiver, so-called ”Sweep Frequency Analyzer (SFA).” This SFA is improved in the time resolution with keeping good frequency resolution by combining the analog frequency conversion and FFT. The SFA consists of an amplifier, a frequency synthesizer, mixers and band-pass filters. These component circuits are fabricated in chips and their performances are tested. The waveform receiver generally consists of the band-limiting filter, the amplifier, the anti-aliasing filter, and the A/D converter. The developed chip contains these circuits except for the A/D converter, and has six-channel to observe full components of the electric and magnetic fields waves. The chip is connected to A/D converters, a clock generator, and power circuits on the PCB. The sampling frequency is 400 kHz, and the dynamic range of the A/D conversion is 14 bits. The total dimension of the PCB containing waveform receiver chip is 50 mm by 90 mm, similar size of a business-card. By the development of the dedicated chip, the weight per channel of the waveform receiver declines to a tenth of the NOZOMI LFA, which was the onboard instrument of the pas Japanese scientific spacecraft.

キーワード: プラズマ波動, 小型化, 集積回路, ASIC, 周波数掃引受信器, 波形捕捉受信器
Keywords: Plasma Wave, Downsizing, Integrated Circuit, ASIC, Sweep Frequency Analyzer, Waveform Capture

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PCG14-11 会場:202 時間:5 月 23 日 14:30-14:45

惑星探査用小型LED ライダーの開発
LED mini lidar for Planetary Exploration

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宇宙にはダストが普遍的に存在している。特に固体惑星の進化を議論する上では重要な役割を果たす。
例えば小惑星の表面や周辺に存在していて、その存在は表面の進化を反映していると考えられる。小惑星表面のダストは、太陽光による帯電で形成される電場によって水平方向に輸送されるとも考えられ、同様の輸送機構は月面上でも起きていると考えられているが、詳細は不明である。
高速宇宙ダストであれば、衝突電離のような衝撃によって発生する現象を利用して従来の宇宙ダスト観測装置で検出・観測できるが、浮遊しているダストをその場観測することはこれまでほとんどなされていない。我々は、ほとんど相対速度を持たないダストを観測するために、地上ではエアロゾルを観測するために使われるライダーについて検討している。通常ライダーは光源にパルスレーザーを利用するが、我々は発光ダイオード（LED）を使うことを検討している。LED を利用することのメリットとして、サージに強くドライバの構成も簡易であることなど、扱いが非常に容易であることが挙げられる。LED の使用によって、装置全体を小型化することができる。
このような LED ライダーは、ライダーが火星着陸ミッション Phoenix に搭載された気象観測ステーションで気象観測装置の一部となったように、気象観測にも利用できるだろう。
また、LED は発光の波長の多様性に富んでいるので、例えば差分吸収法を使ってある特定の大気成分を調べるようなことも比較的容易である。
本講演では、惑星探査用 LED ライダーの開発状況について報告する。

キーワード: 発光ダイオード, ライダー, 惑星探査, 小型, ダスト観測
Keywords: LED, LIDAR, Planetary Exploration, compact, dust observation

Japan Geoscience Union Meeting 2012
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PCG14-12 会場:202 時間:5 月 23 日 14:45-15:00

アナログ ASIC を用いた小型プラズマ波動観測器のアンテナインピーダンス計測システム
The Development of the Miniaturized Antenna Impedance Measurement System using ASIC

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ISHII, Hiromune[1*], Hajime Fukuhara[1], Hirotsugu Kojima[1], Hiroshi Yamakawa[1]

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Space is filled with plasmas. Since space plasmas are essentially collisionless, plasma wave is one of the most essential physical quantities in the solar terrestrial physics. There are two kinds of plasma wave receivers, the sweep frequency analyzer and the waveform capture. While the sweep frequency analyzer provides plasma wave spectra, the waveform capture provides waveforms of plasma waves with wave phase information. Electric field sensors in plasmas show different features from in vacuum. Since plasma is a dispersive medium, the antenna impedances are various complex numbers in the frequency domain. Consequently, in order to calibrate the observed plasma wave data we have to measure not only the antenna impedances but also the transfer functions of plasma wave receiver's circuits precisely. The impedances of the electric field antennas are affected by surrounding plasma density and temperature. However, these states of plasmas change from moment to moment. Thus, we precisely should measure the antenna impedances onboard spacecraft and convert the observed waveform data into the calibrated data. On the contrary, we can obtain the plasma density and temperature from the antenna impedances.

Various systems for measuring the antenna impedance were proposed. A synchronous detection method is used on the Bepi-Colombo Mercury Magnetospheric Orbiter (MMO), which will be launched in 2014. MMO has the onboard digital synthesizer, as a signal source. The synthesized waveforms are fed to the preamplifiers of electric field sensors through a fixed resistor after the D/A conversion.

We can obtain a transfer function of the circuit by applying the synchronous detection method using output waveform, and digitalized signal source. This system is also useful to check the behavior of the waveform capture receiver. The size of this system is same as an A5 board. In recent years, Application Specific Integrated Circuit (ASIC) is in attention which is a technique to integrate large scale and complicated circuits. Lots of ASICs have been applied to high energy astrophysics, though there are few applications in the solar terrestrial physics.

In this paper, we present our attempt to miniaturize the antennas impedances measurement system and Waveform Capture. We design 8bits segment D/A converter synchronized with waveform captures. We improve input logic of the D/A converter to generate a very weak signal accurately.

キーワード: 小型衛星, プラズマ波動観測器, アナログ ASIC
Keywords: Miniaturized satellite, Plasma wave reciever, Analogue ASIC

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-13 会場:202 時間:5 月 23 日 15:00-15:15

ASIC 搭載型 MCP アノードの性能と飛翔実証試験
Flight verification and performance of a discrete MCP anode with ASIC

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近年観測ロケットや人工衛星搭載観測装置による荷電粒子の計測時間分解能は急速に高くなって来ている。計測時間分解能を上げるためにはいくつかの開発項目が存在するが、荷電粒子の検出器開発もその一つである。観測ロケットや人工衛星搭載観測装置による数 eV/q から数十 keV/q の荷電粒子の計測は静電分析器、特に TOP HAT 型の球型静電分析器 [Carlson et al., 1983, Young et al., 1988] を用いることが主流となっており、荷電粒子の検出器としては、円型１次元の位置検出機能を持つものが要求される。静電分析器に入射した電子、イオンの個数をエネルギー毎に計数するパルスカウントを行うために、電子、イオンを増幅する MCP (Micro Channel Plate) と、増幅された電子を収集するアノードを組み合わせたものが広く用いられている。この円型１次元の位置検出機能を持つアノードにもいくつかの異なるタイプの物が存在する。その中で、最も高時間分解能化に適したアノードは、検出する位置毎に電子を収集するための電極を用意し、それぞれの電極にアンプを接続するディスクリートアノードと呼ばれるものである。高時間分解能計測を実現するためには、短いサンプリング時間の間に十分な統計精度を持つだけのカウントを計測できる必要がある。このことは、高いカウントレートに対応したアノードが必要であることを意味している。ディスクリートアノード自体は従来から広く用いられていたが、問題は位置検出の分解能（荷電粒子計測の入射角度分解能に相当する）を上げようとすればするほど多数のアンプを必要としてその結果回路規模や消費電力が観測ロケットや人工衛星に搭載困難なほど大きくなる事であった。そこで、この問題を解決するために開発を開始したのが、多数のアンプとカウンタを含んだ数ミリ角の ASIC (Application Specific Integrated Circuit) を搭載したディスクリートアノードである [Saito M. et al., AIP Conf. Proc. 1144, 48 (2009), DOI:10.1063/1.3169303]。このアノードの開発を開始してから８年が経過したがようやく２回のロケット実験で飛翔実証試験に成功した他、２０１４年打ち上げ予定の水星磁気圏探査衛星 BepiColombo/MMO 搭載イオンエネルギー分析器 MIA のイオンの検出器として搭載するための準備が整った。観測ロケットや、人工衛星に搭載するためには、小型軽量、低消費電力で、打ち上げ時の振動／衝撃に耐え、特に水星ミッションでは宇宙空間における高範囲の温度変化や放射線に対して耐性を有してかつ打ち上げ前の試験環境で性能劣化をおこしにくい物である事が望ましい。そこで、ディスクリートアノードを 1mm 厚のセラミック上の金属パターンで構成し、背面に ASIC をベアチップのままで搭載する構造を採用することにした。電荷を受けるアノードと、信号処理を行うアンプがすぐそばにある事から S ／ N 性能は非常に良いことが明らかになった。ASIC を BARE CHIP のままで使用することから、微細なボンディングを短絡から保護する等の目的で電荷を収集する部分を除くアノード全体をパリレンでコーティングする方法を採用し良好な結果を得ている。これまでに、Total Dose, Single Event Latch Up を含む放射線照射試験、マイナス４０度から８５度までの熱サイクル試験などを実施し、良好な結果を得ている。また性能的には周期的なパルスであれば１ CH 当たり 25MHz までの計測を行う事ができることを確認した。

これまでにこの ASIC 搭載型 MCP アノードは、ノルウェーの観測ロケット実験 ICI-2, ICI-3 (Investigation of Cusp Irregularity-2, 3: それぞれ２００８年１２月と２０１１年１２月にノルウェーのスバルバード島から打ち上げ) に搭載した低エネルギー電子計測装置 LEP-ESA の電子検出器として使用し、２回の飛翔ともにカスプ周辺のプラズマ擾乱現象の存在する領域での高時間分解能電子計測に成功した。今後、水星磁気圏探査衛星 BepiColombo/MMO 搭載イオンエネルギー分析器 MIA のイオンの検出器として使用する他、小型低消費電力、高時間分解能が要求される将来のミッションに本 ASIC とその搭載技術は広く応用する事ができるものと期待している。

キーワード: 荷電粒子, 検出器, ASIC, MCP アノード
Keywords: charged particle, detector, ASIC, MCP anode

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-14 会場:202 時間:5 月 23 日 15:30-15:45

将来惑星探査へ展開する小型電波受信センサーシステムの開発
Development of small-sized radio sensor for future Jovian mission

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Future Jovian mission is now planned for 2020s. One of its major objectives is the investigation of electromagnetic system connected and drived by Jupiter. Under the international collaborations, we have started the development for the small-sized radio sensor for this mission from 2011. We succeeded to establish the base technical elements for (1) light-weight rigid antenna with simple and reliable extension capability and (2) small-sized radiation-hard preamp with the highest sensitivity.

In any missions related to plasmas, electric field from DC to several 10s MHz has contributed to the remote-sensing and in-situ studies of dynamics and energetic interactions in the electromagnetic system, associated with remote optical measurements and in-situ particle and magnetic field sensors.

For the Jovian project, Euro-USA-Japan joint team is formed for the plasma and radio wave studies. Especially in Jupiter, it is important as a remote sensing tool for the direct measurement of Jovian radio source regions distributing around the Jovian system, i.e., polar region, radiation belts, Io torus system, and several satellites with thin atmospheres like Io, Europa, Ganymede, and Calisto. We are involved for this topic, based on the Plasma Wave Investigation (PWI) aboard the BepiColombo/MMO, and started the small-sized radio sensor package with antenna and preamp within the tightest resource limitations.

In 2011, we investigated base technologies for (1) a 3-axial antenna with 2m length, extracting at the Earth orbit and can be kept along the long travel to the orbit around Galilean satellites, and (2) a 3-axial preamp covering 10 kHz - 50 MHz with highest sensitivity, enough radiation tolerance in Jovian environment (the hardest in the solar system), within the mass limit less than 200g, and

For the former, we established the simple extension mechanism based on the self-extracting thin metal element, which is based on the combination of the SCOPE Z-axis antenna (STEM-type extension mechanism but with a complex motor system) and the sounding rocket antenna (self-extraction antenna but limited within 1m extension length). For the latter, under the collaboration with the IRF Uppsala (Sweden) team, we established the key parts of the radiation-hard analogue custom IC technologies, in which the most difficult part was a relay in the package with high-impedance, small-sized, and high-reliability enough. In parallel, we also tested the high-sensitivity preamp BBM under the radiation hard condition, and proved that even in 200 krad the degradation of the noise level is only the twice, without critical linearity and sensitivity damages. In 2012, we will proceed to the next phase.

These small but reliable extension mechanism and electronics are not so much expensive. Therefore, we consider to apply them to sounding rocket experiments. It can be also adopted to any space and planetary missions in which the resource is very tight.

キーワード: 電場, プラズマ波動, 電波, アンテナ, センサー, 木星
Keywords: electric field, plasma wave, radio wave, antenna, sensor, Jupiter

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-15 会場:202 時間:5 月 23 日 15:45-16:15

Means to avoid the contamination effect of Langmuir probe measurement for ionosphere studies

Means to avoid the contamination effect of Langmuir probe measurement for ionosphere studies

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Some scientists are still not aware of the serious effect of electrode contamination in Langmuir probe experiments in space, or they do not take any action for that even though they are aware of the seriousness. We stress here that one should pay extra small attention to the electrode contamination to get accurate and reliable parameters, by which the long time effort for sounding rocket/satellite mission does not end in vain. In this paper we describe two main features of voltage-current characteristic curves associated with contaminated Langmuir probe, which are predicted from equivalent circuit model which we proposed in 1970's. We then show that that fast sweep DC Langmuir probe can give reliable result in steady state regime. The first sweep probe can also give a reliable result in transient situation such as the passing through plasma bubble in the ionosphere where electron density suddenly changes, after the several sweep cycle of the probe voltage. This fact is first confirmed through Laboratory experiment.

キーワード: Ionosphere, Surface contamination, Langmuir Probe
Keywords: Ionosphere, Surface contamination, Langmuir Probe

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-P01 会場:コンベンションホール 時間:5 月 23 日 17:15-18:30

磁気圏探査衛星搭載用フラックスゲート磁力計のための ASIC 開発
Development of the ASIC for fluxgate magnetometers onboard space exploration satellites

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フラックスゲート磁力計は小型、軽量、省電力でありながら非常に高精度である。そのため、フラックスゲート磁力計は古くから科学観測衛星に搭載され、地球や他の惑星磁気圏、惑星間空間の磁場を観測してきた。近年、惑星磁気圏探査機に搭載される科学観測機器は従来の性能を保ちながら、電力や重量等のリソースを削減しなければならない。実際に計画、進行中の磁気圏探査計画や将来の科学観測ミッションにおいてリソースの削減は大きな課題となっている。

このような状況の中でフラックスゲート磁力計の小型化、軽量化、省電力化を実現するために ASIC の開発が必要とされている。我々は「信号処理回路のディジタル化」と「ASIC によるプリアンプ、バンドパスフィルタの小型化」という手法によって、より一層のリソースの削減を実現させる。ディジタル化したフラックスゲート磁力計は科学観測ロケット S-310-38 号機、40 号機に搭載し、実証試験を行ってきた。

今回の発表では ASIC の設計結果を中心に報告する。設計した ASIC はそれぞれ 1 種類の増幅回路とバンドパスフィルタ回路で構成されている。ASIC のチップ面積は 5 mm 角であり、使用面積は 5 mm x 1 mm 程度である。増幅回路の増幅率は外部信号により 2 倍から 10 倍まで変更できる。バンドパスフィルタは 2 次型バターワースフィルタを採用し、中心周波数はフラックスゲート磁力計のピックアップ信号の周波数である 22 kHz にあわせてある。ASIC の機能や性能評価は電子回路シミュレータを用いて検証した。さらに、-30 度から 50 度の温度範囲で ASIC の機能や性能が損なわれないことも確認した。設計した回路の消費電流は 1 mA で、消費電力は約 5 mW であった。出力のダイナミックレンジは 0.24 F.S. であり、1.2 V に相当する。増幅回路とバンドパスフィルタで発生するノイズは 600 nV/Hz$^{1/2}$ @ 1 Hz（2 pT/Hz$^{1/2}$ に相当）以下と小さく、センサのノイズと同等またはそれ以下である。シミュレーションの結果から ASIC が正しく機能し、要求に対して十分な性能が得られたことを確認した。

キーワード: フラックスゲート磁力計, ASIC, ディジタル方式, アンプ, バンドパスフィルタ
Keywords: fluxgate magnetometer, ASIC, digital-type, amplifier, band-pass filter

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-P02 会場:コンベンションホール 時間:5 月 23 日 17:15-18:30

WPIA 計測における不確定性の考察
Statistical evaluation of the fluctuation of the WPIA analysis

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波動粒子相互作用解析装置 (Wave-Particle Interaction Analyzer; WPIA) は，Fukuhara et al. (EPS 2009) によって提唱された，宇宙プラズマ中の個々の粒子と波動との相互作用を直接的かつ定量的に計測する新しい観測装置である．WPIA はプラズマ波動電磁場ベクトルと粒子の速度ベクトルからその位相差を求め，様々な演算を行うことで波動―粒子間のエネルギー輸送を計測する．地球放射線帯外帯における相対論的電子の生成過程においては，ホイッスラーモードコーラス放射と相対論的電子との波動粒子相互作用が重要な役割を果たすことが指摘されている．次期内部磁気圏探査衛星計画 ERG では，コーラス放射と相対論的電子との波動粒子相互作用を直接観測すべく，WPIA が搭載される予定である．WPIA については計測装置の工学的研究が進められている一方，計測原理と手法に関する物理的詳細の検討が課題として残されている． 本研究は WPIA の計測手法の具体例として，ジュール熱に相当する物理量 $W=\Sigma\ qE\cdot v$ の計測に着目し，計測される物理量や計測手法に内在する物理的意味を明らかにすることを目的とする．本発表では，物理量 W の統計的不確定性に関して考察し，計測によって求められる値の統計的有意性の評価方法を提案する．さらに，コーラス放射の励起過程ならびにコーラス放射による相対論的電子加速過程の双方を自己無撞着に再現した Katoh and Omura (GRL 2007a, 2007b) による計算機実験結果を用いて，WPIA の解析手法に基づく疑似計測を行い，本研究で提案した評価手法の有用性を実証する．また，提案した評価手法に基づき，実際の衛星観測における計測可能性についても言及する．

キーワード: 波動粒子相互作用解析装置 (WPIA), 波動粒子相互作用, ホイッスラーモードコーラス放射, 地球放射線帯, ERG 衛星
Keywords: Wave-Particle Interaction Analyzer (WPIA), wave-particle interaction, whistler-mode chorus emission, radiation belts, ERG

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-P03 会場:コンベンションホール 時間:5 月 23 日 17:15-18:30

電離圏電子密度高分解能計測のための白色雑音印加型インピーダンスプローブの開発
Development of white-noise-applied impedance probe for high resolution electron density measurements in the ionosphere

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Impedance probe is an instrument for electron number density measurements by using frequency dependence of the capacitance of the probe antenna extended into the space plasma. Due to its high accuracy and independency from probe shapes and plasma conditions, it has been installed on numerous sounding rockets and provided vertical profiles of electron number density in the ionosphere. The spatial resolution of the current impedance probe system, 100 m, is determined by the sweep period of frequency of the local signal applied to the AC bridge. On the other hand, the spatial scale of the field aligned irregularity (FAI) in the ionosphere, which has been observed by the radars on the ground, is several meters. Therefore, those phenomena can not be observed by the current impedance probe system. In order to solve the problem, we are now planning the development of a new impedance probe system which uses white noise instead of the swept-frequency signal. The results of preliminary plasma chamber experiment and development plan will be shown in the presentation.

Keywords: Impedance probe, Electron number density, Field aligned instability (FAI)

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-P04 会場:コンベンションホール 時間:5 月 23 日 17:15-18:30

Development of Electron Temperature and Density Probe(TeNeP)
Development of Electron Temperature and Density Probe(TeNeP)

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To prepare for the near future satellite missions, we propose to develop a new instrument ? the Electron Temperature and Density Probe (TeNeP) and conduct its test and calibration in the Space Plasma Operation Chamber (SPOC, 2m in diameter and 3m in length) of the Plasma and Space Science Center, National Cheng Kung University (PSSC/NCKU). PSSC/NCKU has completed the development and test of an Electron Temperature Probe (ETP) to measure the electron temperature and an Impedance Probe (IP) to measure the electron density for deployment in the observation in the ionosphere. Because the ETP and the IP make use of the same electrodes and similar electronics, we develop a new Electron Temperature and Density Probe (TeNeP)by combining the design and function of the Electron Temperature Probe and the Impedance Probe. The TeNeP can measure the electron temperature and electron density successively in the satellite altitude below 3000 km.

キーワード: Small satellite, Ionosphere, Electron density, Electron temperature
Keywords: Small satellite, Ionosphere, Electron density, Electron temperature

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-P05 会場:コンベンションホール 時間:5 月 23 日 17:15-18:30

Gean4 によるあけぼの RDM 計測器の放射線帯データ検証：電子陽子アルファ相互データ混入
Reciprocal contamination between electrons, protons and alphas in the radiation belts: Akebono RDM and Geant4 simulation

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Geant4 粒子追跡シミュレーションツールをもちいて、1989 年打上げ、高度数千 km の準極軌道を取る「あけぼの」衛星搭載の放射線モニター（RDM）の検証を行い、データ混入の除去、およびエネルギーレンジの補正値の導出に取り組んできた。RDM 検出器は、高エネルギー電子 3 チャンネル（> 2.5, 0.95-2.5, 0.3-0.95 MeV）、プロトン 3 チャンネル（30-38, 15-30, 6.4-15 MeV）、アルファ粒子 1 チャンネル（15-45 MeV）の測定を、現在も継続して行っている。RDM 検出器をシミュレーション空間内に構築し、電子、陽子、アルファ粒子のそれぞれについて、さまざまなエネルギーを設定して粒子入射を行い、粒子の軌道追跡を行った。このシミュレーションでは、入射粒子と物質の衝突散乱を再現し、入射粒子だけでなく衝突等によって生成される二次粒子も追跡する。シミュレーションの結果、電子が検出器の内部で極めて複雑な振る舞いをすることが分かった。最もよく散乱される電子のエネルギーは、測りたい対象、すなわち地球放射線帯の主成分のエネルギー帯（1 MeV 付近）のものであった。検出器内部のシリコン検出部における吸収エネルギーを調査した結果、陽子とアルファ粒子は、ほぼ理論予測のとおりの吸収エネルギーが測定されたのに対し、電子の吸収エネルギーは、理論予測に対し分散の大きい分布を示していた。さらに、粒子追跡シミュレーションにより、検出効率にエネルギー依存があることが明らかになったため、検出器開発当時の古い資料をもとに吸収エネルギー信号回路とデータ検出アルゴリズムを再現し、エネルギーチャンネルごとに、検出効率のエネルギー依存を考慮したデータ補正項の導出に取り組んだ。電子データの検証のために、内部磁気圏での観測データを、NASA の CRRES 衛星による同時観測データと比較し、また、陽子データの検証のために、高緯度における観測データを、NASA 公開の太陽風データに含まれる太陽フレア粒子と比較した。その結果、各粒子チャネル間での相互データ混入が明らかになった。L<3 の内部磁気圏では電子データへの陽子の混入が顕著であること、また、L~4-6 の放射線帯外帯の領域では陽子チャネルの値を電子データとして扱うことが出来ること、さらに、L>8 の高緯度領域では、陽子およびアルファ粒子チャンネルが正確なデータを出していることが確認できた。1989 年と 1999 年までの太陽フレア粒子イベントとの比較による結果では、太陽アルファは太陽プロトンの一割程度との報告がされている通り、高緯度帯では RDM でもプロトンの一割程度のアルファが観測していることが確認でき、時に、それが磁気嵐のときに L~4 以内のかなり内部まで侵入できていることが新たに分かった。

キーワード: 放射線帯, 高エネルギー粒子, 粒子検出器, Geant4, 太陽フレア粒子
Keywords: radiation belts, high energy particles, particle detector, Geant4, solar energetic particles

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-P06 会場:コンベンションホール 時間:5 月 23 日 17:15-18:30

Atmospheric Neutral Analyzer for neutral mass composition and velocity measurement in the upper atmosphere

Atmospheric Neutral Analyzer for neutral mass composition and velocity measurement in the upper atmosphere

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Atmospheric Neutral Analyzer for neutral mass composition and velocity measurement in the upper atmosphere

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In order to understand the variability of the ionosphere-thermosphere system, in-situ measurements of the composition and density of the neutral atmosphere and the detailed velocity distribution of individual species are required. However, most conventional types of instruments for neutral atmosphere lack the simultaneous capability of measuring neutral atmospheric velocity and resolving neutral mass.

We are designing the Atmospheric Neutral Analyzer (ANA) instrument to measure neutral composition and velocity distribution simultaneously in the thermosphere. It is designed to measure the detailed, mass-resolved 2 dimensional velocity distribution of thermospheric neutral species, and to derive the corresponding density, mass composition, velocity and temperature from the measured distribution.

The ANA is comprised of 4 sections; Entrance Aperture (EA), Ion Accelerator (IA), Radio-Frequency Ion Mass Analyser (MA) and Imaging Particle Detector (PD). The EA consists of a planar aperture slit and deflection electrode, and functions as an incident-particle selector and collimator. A small fraction of the neutral particles is ionized by electron beam. The IA acts as a particle energy selector by accelerating the ionized particles. The RF acts as an ion velocity selector. The RF voltage is applied to grids and selectively accelerate ions of matching speed. As a result, ions with a particular mass-per-charge are selected. The PD, which is comprised of a retarding grid, micro-channel plate and charge coupled device, acts as a detector of the selected ions and a two dimensional velocity imager.

We present the concept and the detailed design of the ANA.

キーワード: 風速測定, 温度測定, 質量分析, 熱圏電離圏結合
Keywords: wind measurement, temperature measurement, mass analysis, thermosphre-ionosphere coupling

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-P07 会場:コンベンションホール 時間:5 月 23 日 17:15-18:30

宇宙機搭載同位体計測用 multi-turn time-of-flight 型質量分析器
Spaceborne multi-turn time-of-flight mass spectrometer for isotope analysis

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In situ low-energy ion measurement in terrestrial or planetary plasma environment has been done with a variety of ion analyzers. Detailed studies of plasma characteristics demand not only energy analysis but also mass analysis. When measuring a variety of ions originating from planetary atmospheres, we need to be able to measure the ion composition with high mass resolution. As we achieve the measurements of the ion composition by mass analyzers around planetary environment, higher mass resolution is needed in order to distinguish heavy species and isotopes. For the future isotope measurements around moons, planets and asteroids, we are developing a high-mass-resolution mass analyzer. One of our scientific objects is to measure the Martian atmospheric escape and evolution. Although mass resolution (m/dm) of 100 is generally needed for the isotope analysis of planetary particles, the Martian atmospheric escape and evolution science requires m/dm>3,000 to discriminate N2 from CO.

ISAS particle measurement group has developed a time-of-flight(TOF) ion mass analyzer with mass resolution of about 20 for KAGUYA, which succeeded in measuring ions originating from the lunar exosphere and surface. It is also preparing a TOF mass analyzer with mass resolution of 40 for the BepiColombo mission. Multi-turn TOF mass spectrometers(MULTUM), where ions are stored in a fixed orbit within electrostatic sectors and allowed to propagate the same orbit numerous times, have been developed by Osaka Univ. mass spectrometry group. One of the MULTUM series achieves the mass resolution over 30000 with the size of 20cm x 20cm. Our isotope analyzer in development for the future planetary mission employs the MULTUM system. We will show the spaceborne MULTUM analyzer and report the development schedule.

キーワード: 質量分析, 同位体分析, マルチターン型
Keywords: mass analysis, isotope analysis, MULTUM

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-P08 会場:コンベンションホール 時間:5 月 23 日 17:15-18:30

MMO 搭載 MIA センサー特性の数値モデルと実験結果
Numerical model and calibration experiment on the sensor characteristics of MIA/MMO

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The Mercury Ion Analyzer (MIA) is one of the plasma instruments on board the Mercury Magnetospheric Orbitor (MMO). and measures the three dimensional velocity distribution of low-energy ions (5 eV to 30 keV) by using a top-hat electrostatic analyzer for half a spin period (2 sec). By combining both the mechanical and electrostatic sensitivity controls, MIA has a wide dynamic range of count rates for proton flux expected around Mercury, in the the solar wind between 0.3 and 0.5 AU from the sun and in the plasma sheet of Mercury’s magnetopshere. In this presentation, we discuss the sensor characteristics from both model calculations and calibration experiment of the flight model.

Keywords: MMO, Mercury, solar wind

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-P09 会場:コンベンションホール 時間:5 月 23 日 17:15-18:30

SPRINT-A/EXCEED ミッションに向けたコンタミネーションの定量的評価
The evaluation of the contamination on the EUV reflectance for the SPRINT-A/EXCEED mission

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SPRINT-A/EXCEED ミッションは、地球周回軌道から地球型惑星の散逸大気や木星内部磁気圏を極端紫外光で観測することを目的とし、2013 年度の打ち上げを目指して現在開発が進められている。本観測器の光学系は主鏡と反射型回折格子および 2 次元光検出器で構成される。観測対象の光が微弱なため、主鏡と反射型回折格子には高い反射率と回折効率が求められる。

極端紫外光観測において、光学素子表面の分子コンタミネーションは効率を著しく低下させ得る。したがって地上環境試験や軌道上での徹底したコンタミネーション管理が必要である。そこで我々は本ミッションの構成品のうち、コンタミネーションの原因となり得る数種類の材料について、極端紫外光反射率に及ぼす影響を定量的に評価した。本発表では我々が行った試験の結果を紹介し、SPRINT-A/EXCEED ミッションの光学系の性能を維持するための指針を示す。

キーワード: コンタミネーション, 極端紫外光
Keywords: contamination, extreme ultraviolet

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-P10 会場:コンベンションホール 時間:5 月 23 日 17:15-18:30

ISS 搭載可視分光器 IMAP/VISI による大気光観測：打上直前状況
Airglow observation mission with a visible spectrometer IMAP/VISI on ISS: Current status for the launch

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The ISS-IMAP mission is one of the Japanese Experiment Module (JEM) 2nd stage plan which will be launched in the summer of 2012 onto the International Space Station (ISS) with HTV (Konotori) We completed the development and manufacturing of a visible imaging spectrometer instrument (VISI) for this mission. VISI will measure to measure three nightglow emissions; O (630 nm, altitude 250 km), OH Meinel band (730 nm, altitude 87km), and O2 (0-0) atmospheric band (762 nm, altitude 95 km) with the two field-o-views which enable us to make a stereoscopic measurement of the airglows looking forward (+45 deg.) and backward (-45 deg.) to subtract contaminations from clouds and ground structures. We designed a bright (F/0.9), wide-angle (field-of-view 90 degrees) objective lens. VISI have a two-line-slit on the first focal plane to perform the stereoscopic measurement. Each slit, i.e., field-of-view, is faced perpendicular to the orbital plane, and its width is about 550 km mapping to an altitude of 100 km. We will obtain a continuous line-scanning image for all emissions line from + 51 deg to -51 deg. in geographic latitude by the successive exposure cycle with a time interval of 1 - several sec.

We carried out so far the optical test including the adjustment of focus and alignment, intensity calibration, function check, vibration and vacuum thermal tests. We also performed the system integration test on the Multi-mission Consolidated Equipment (MCE). In this February, MCE will be mounted on the H-IIB rocket at the Tanegashima Space Center of JAXA. We present the development of VISI, and the current status for the launch in this summer.

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-P11 会場:コンベンションホール 時間:5 月 23 日 17:15-18:30

赤外レーザヘテロダイン分光器MILAHIを用いた超高分解能惑星大気観測
Ultra-high resolution observations of planetary atmospheres using Mid-Infrared LAser Heterodyne Instrument (MILAHI)

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We have developed a ultra-high spectral resolution spectrometer, called Mid-Infrared LAser Heterodyne Instrument (MILAHI). It is for the applications to astronomy and planetary atmospheric science in 7-11 um wavelength at a spectral resolution resolution of up to 10^{7-8} and a bandwidth of 1GHz. We just finish the development phase of this project.

High-resolution spectroscopy in the mid-infrared regime is a versatile tool for studies of planetary atmospheres. With the highest possible spectral resolution provided by heterodyne techniques, fully resolved molecular features enables us to retrieve many physical parameters from single lines migrated in strong absorption of terrestrial atmospheric molecule bands. Because many key species in the planetary atmosphere are also abundant in the terrestrial atmosphere, high-resolution directly leads to less ambiguity. It also allows us to measure slow wind velocities with the order of 10-100m/s directly.

The heterodyne spectroscopy has been developed by our group from 1980s, in order to detect minor constituents in the terrestrial atmosphere [Taguchi et al., 1990]. The renovation with a wide-band detector, the quantum-cascade (QC) lasers and CO_2 gas laser allows us to apply this instrument to tiny planetary atmosphere.

Our performance achieved the proper level for this target. (1) System noise: At 10.3 um, we achieved 3000 K (NEP of 2.24 $W/Hz^{1/2}$ at 3MHz resolution). It leads to a minimal detectable brightness temperature difference of 37mK within 10min at 1.5 MHz bandwidth, corresponds to a minimum flux difference of 0.48 ergs/(scm2cm-1Sr) for extended source. (2) Spectral resolution: It can be achieved to be 20 MHz with a feedback using gas-cell absorption spectra.

The telluric CO_2 and O_3 absorption spectra had been obtained from the sunlight background in the lab at Sendai. On January in 2012, our equipment was mounted on the Higashi-Hiroshima 1.5m telescope, and succeeded to detect the telluric O_3 spectra obtained from moonlight. We also aimed Venus and standard stars. Unfortunately, the final success was prevented by bad weathers, but the S/N gained by these target told us that we should get the Venus and Mars spectrum with this design.

Now, we try to refine the emission spectra of the QC lasers, which provide us very wide tuneability ($5cm^{-1}$, and $20cm^{-1}$) to operate the heterodyne system.

Although a telescope dedicated to this instrument does not exist yet, we expect to attach it to the PLANETS telescope at the top of Mt. Haleakala at Hawaii, which is now in development by PPARC / Tohoku Univ. with IfA / Univ. Hawaii (USA), Kiepenheuer Inst. f. Sonnen. (Germany), Univ. Nac. Aut. de Mexico, Univ. Turku (Finland), Harlingten Inovative Optics Co. (USA), Stan Truitt Breckenridge Astronomycal Ltd (USA), and collaborators. Its first light is, if all things are going well, in 2014.

キーワード: 分光, 赤外, 惑星大気, 高分解能, ヘテロダイン, レーザー
Keywords: spectroscopy, infrared, planetary atmospheres, high spectral resolution, heterodyne, laser

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-P12 会場:コンベンションホール 時間:5 月 23 日 17:15-18:30

宇宙塵観測のための電流-電圧変換アンプを利用した PZT 検出器
PZT sensor with current-to-voltage converting amplifier for dust observation

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This paper describes the concept of a dust monitor with a large detection area but less resource consumption using lead zirconate titanate (PZT) ceramics, and the possibility is experimentally demonstrated. PZT sensors, which are traditional devices for in-situ observation of hypervelocity dust particles, have been used for momentum measurement. The hypervelocity impact signals of PZT sensors are typically read by charge-sensitive amplifiers. Instead, we suggested the use of a current-to-voltage converting amplifier for interpreting the impact signal of a PZT sensor to determine the size of a dust particle down to 0.5 um in radius. If a sufficient number of such PZT sensors cover the interspaces of instruments on interplanetary-space-cruising spacecraft, datasets of dust impacts can be obtained with higher statistical precision than that of previous observations. Such observations can provide insights into unresolved science problems in interplanetary dust research.

キーワード: 宇宙塵観測, 圧電性 PZT, 電流電圧変換アンプ
Keywords: cosmic dust observation, piezoelectric PZT, current to voltage conversion amplifier