

Japan Geoscience Union Meeting 2011

(May 22-27 2011 at Makuhari, Chiba, Japan)

©2011. Japan Geoscience Union. All Rights Reserved.



PPS001-01

Room:101

Time:May 27 08:30-08:45

Possible Japanese contributions to the Jupiter system exploration in 2020's

Masaki Fujimoto^{1*}

¹ISAS, JAXA

In this talk, a summary of the Japanese EJSM WG efforts made in the FY2010 will be given. The first issue is the planning of JMO (Jupiter Magnetosphere Orbiter). JMO is assumed to fly together with EJSM spacecraft, namely, JEO (Jupiter Europa Orbiter, to be provided by NASA) and JGO (Jupiter Ganymede Orbiter, to be provided by ESA), and is planned to perform imaging of the space environment that the Galilean moons are embedded in and whose dynamic behavior the two EJSM spacecraft will observe. The study on the JMO orbit design have shown that the imaging from a vantage point at high-latitude is possible as we utilize the gravity assist from Calisto to raise the inclination of the orbit. Together with the fruitful discussion regarding what instrument suite should be onboard JMO, it shows the exciting aspect of the multi-spacecraft exploration of the Jupiter system. The second issue is on the Japanese participation in JEO and JGO. Several members of the WG have been invited to join various instrument teams that will submit their proposals once the call is made. While competitive at the micro-scale, at the macro-level, the JMO WG will support every invited members so that substantial Japanese contributions at the instrument level to THE mission of the 2020's are secured.

Keywords: EJSM, Jupiter system, Europa, Ganymede, Plasma imaging, JMO

Japan Geoscience Union Meeting 2011

(May 22-27 2011 at Makuhari, Chiba, Japan)

©2011. Japan Geoscience Union. All Rights Reserved.



PPS001-02

Room:101

Time:May 27 08:45-09:00

Trojan Asteroids and the Early Evolution of the Solar System

Patryk Sofia Lykawka^{1*}, Jonathan Horner², Barrie Jones³, Tadashi Mukai⁴

¹Faculty of Soc. & Nat. Sci., Kinki Univ., ²University of New South Wales, ³The Open University, ⁴Graduate School of Science, Kobe Univ.

Trojan asteroids can be used to constrain Trojan formation mechanisms, giant planet formation/migration and the orbital structure in the asteroid and Kuiper belts. We performed numerical simulations totaling a few million massless objects under the gravitational influence of the four giant planets. Overall, Neptunian Trojans were obtained at the end of planet migration, composed of remaining local (primordial) and captured Trojan asteroids. In addition to Neptune, the other three giant planets were also able to capture and retain a significant population of Trojan objects from the planetesimal disk after planet migration. In general, captured Trojans yielded a wide range of eccentricities and inclinations, while local Trojans survived with colder orbital conditions. However, the bulk of captured objects decay over Gyr, providing an important source of new objects on unstable orbits (the Centaurs). Our results suggest the bulk of observed Jovian and Neptunian Trojan populations were captured from the primordial planetesimal disk during planet migration, but their high-*i* component (>20-25 deg) remain unexplained so far.

Keywords: Edgeworth-Kuiper belt, Solar system, Orbital resonances, Trojan asteroids, Neptune, Trans-Neptunian objects (TNOs)

Japan Geoscience Union Meeting 2011

(May 22-27 2011 at Makuhari, Chiba, Japan)

©2011. Japan Geoscience Union. All Rights Reserved.



PPS001-03

Room:101

Time:May 27 09:00-09:15

Scientific Rationale for Exploring Jovian Trojans

Hajime Yano^{1*}, Jupiter and Trojans Exploration Working Group Preparation Team¹

¹JAXA/ISAS & JSPEC

Jovian Trojan asteroids have been considered as one of a few remaining final frontiers within our Solar System, which may hold fundamental clues of the solar system formation and evolution, as suggested by the discussion about their genesis between the classic model and the more recent Nice model. The former suggests that Trojan asteroids are mainly survivors of building blocks of the Jupiter system, while the latter claims that they must be intruders from outer regions after the planetary migration of gas planets settled. In the past, scientific investigations of these dark, distant asteroid reservoirs were largely dependent upon ground observations by large optical and spectroscopic telescopes and few definite D-type analog meteorites were collected on the earth. However, thanks to recent development of observational technologies such as AOs, statistical studies of asteroids in Jovian L4 and L5 regions have been made possible and raised new questions about their compositions far beyond snow lines and internal structures implied by binary systems. This paper discusses major scientific questions about such not-well-known Jovian Trojans and the potential of in-situ observations and explorations of such bodies to resolve some of them, together with possible instrumental and operational options.

Keywords: Jovian Trojans, Nice Model, Solar System Formation, D-type Asteroids, Binary Asteroids, Exploration Project

Japan Geoscience Union Meeting 2011

(May 22-27 2011 at Makuhari, Chiba, Japan)

©2011. Japan Geoscience Union. All Rights Reserved.



PPS001-04

Room:101

Time:May 27 09:15-09:30

Development of Solar Power Sail System for Future Jupiter System Exploration

Ryu Funase^{1*}, Osamu Mori¹, Yuichi Tsuda¹, Hirotaka Sawada¹, Takanao Saiki¹, Junichiro Kawaguchi¹

¹JAXA

JAXA has been studying solar power sail technology for future outer solar system exploration and is planning to launch middle-sized Jupiter system probe in late 2010s. As a stepping stone for enhancing the technology readiness level toward this mission, a small solar power sail demonstration probe "IKAROS" was developed and launched in 2010, which became world's first solar sail in space and successfully demonstrated several essential technologies such as solar sail deployment, power generation by large area thin film solar cells and orbit control by solar sail. In this presentation, the achievements by the IKAROS probe and current development status of solar power sail for Jupiter system exploration.

Keywords: solar power sail, electric propulsion, Jupiter exploration

PPS001-05

Room:101

Time:May 27 09:30-09:45

Turning point in differentiation history of giant icy satellites induced by dehydration of pristine hydrous rock

Jun Kimura^{1*}, Kiyoshi Kuramoto¹

¹CPS/Hokkaido University

From gravity data, it has been found that Ganymede has a small value of the moment of inertia (MoI) factor (0.3115), which suggests a highly differentiated interior (an outermost H₂O layer, a rocky mantle, and a metallic core). Also, existence of the intrinsic magnetic field strongly supports the existence of a (at least partially) liquid, iron-rich core. However, process of the internal differentiation including the core formation is highly unclear, and the size of Ganymede implies that only accretional heat is insufficient to segregate the water, rock, and metallic materials completely. On the other hand, Callisto has similar size to Ganymede but show larger value of MoI (0.355) implying incomplete differentiation. Many hypotheses to explain this contrasting characteristic between two moons have proposed. Here we suggest another hypothesis for the internal evolution in early stage and focus on a dehydration process of pristine rock-metal-mixed core.

Although Ganymede and Callisto share similar size and mass, estimated masses of rocky component including metal derived from the mean density of both moons are considerably different each other in the viewpoint of the thermal history. Assumed that both moons consist of two components (water with density of 930 kg m⁻³ and rock with density of 3,300 kg m⁻³), the mass of rocky component is equivalent to a rocky core with radius about 1,980 km for Ganymede and 1,750 km for Callisto. This means that the radiogenic heat amount is different (Callisto has about 70 % amount of Ganymede's radiogenic heat source), assumed the same concentration of radioactive elements. However a preliminary evaluation shows that the temperature of the primitive core in both moons will be exceed the liquidus of metallic component (1250 K) and the metallic core will be formed within 1-2 Gyr, given the viscosity law of dry peridotite for the primitive cores. This result contradicts the gravitational data and its aspect to the differentiated state. Therefore it is difficult to create the dichotomy of internal state between two moons only by the difference of their silicate fraction (which corresponds to the radiogenic heat source), and thus another factor is needed.

Dehydration of hydrous rock and associated rheological change might be a key to create the dichotomy. We assume rocky component is possibly hydrated during the accretion, and hydrous rock-metal-mixed pristine core starts to warm due to radiogenic heat after the end of accretion. Once the dehydration starts to occur, the temperature of rocky core would increase more rapidly and exceed the melting point of the metallic component, and thereby metal segregates from rocky material. If Ganymede which has larger amount of radiogenic heat has experienced the dehydration, and if Callisto has not, the dichotomy in differentiation state between both satellites would be explained.

To test above idea, we performed numerical simulations for the internal thermal evolution taking into account the heat transport by convection and conduction. In a reasonable range of viscosity is assumed for hydrated rocky core, model Ganymede experiences the dehydration of the pristine mixed-core and possibly the metallic component could segregates from the rocky materials in case of the high silicate content and/or higher viscosity of hydrous rock. On the other hand, Callisto does not undergo dehydration because of the smaller amount of radiogenic heat. The difference of radiogenic heat and the dehydration process have potential to create the dichotomy between two moons. Moreover, this may also explain the geological records on Ganymede showing the occurrence of global extension after the period of heavy bombardment. Global mapping with high spatial resolution in future mission on giant icy moons and improvement of accuracy in cratering chronology (e.g., current estimate on Ganymede's bright grooved terrain has uncertainty of an order of Gyr) are needed to examine our hypothesis.

PPS001-06

Room:101

Time:May 27 09:45-10:00

Gas Accretion Flow onto Circum-Planetary Disks and the Disk Structure

Takayuki Tanigawa^{1*}, Keiji Ohtsuki², Masahiro Machida³

¹ILTS, Hokkaido University, ²Kobe University, ³NAOJ

Satellite systems around gas giant planets are thought to be formed in circum-planetary disks, which are believed to exist at the gas capturing growing phase of giant planets. However, the structure of the circum-planetary disks are poorly known and thus current formation theories of satellite systems are forced to be constructed under not-well-established disk structures, which could impact the results.

In this study, we performed a series of hydrodynamic simulations of gas accretion flow onto circum-planetary disks from proto-planetary disks in order to analyze the structure of circum-planetary disks. We found that distribution of gas accretion flux onto the disk is well described by a power-law function of distance from the planet, which will be the basis to construct the circum-planetary disk structures in a steady state.

Keywords: satellites, giant planets, disks, hydrodynamic simulation

Japan Geoscience Union Meeting 2011

(May 22-27 2011 at Makuhari, Chiba, Japan)

©2011. Japan Geoscience Union. All Rights Reserved.



PPS001-07

Room:101

Time:May 27 10:00-10:15

Polar motion of Titan forced by the atmosphere

Tetsuya Tokano^{1*}, Tim Van Hoolst², Ozgur Karatekin²

¹IGM, University of Cologne, ²Royal Observatory of Belgium

Titan's atmosphere possesses an equatorial component of angular momentum, which can be transferred to the surface and excite polar motion of Titan. The atmospheric excitation of Titan's polar motion is calculated using the wind and pressure data prediction from a general circulation model. The polar motion equation is solved considering Titan's triaxial shape and different hypothetical interior models. Titan's polar motion basically consists of a superposition of diurnal wobbles and semi-annual and annual wobbles caused by seasonal redistribution of wind and pressure pattern. If the entire interior of Titan is solid, the polar motion has amplitudes of a few meters and the paths of the diurnal and seasonal wobble are intermingled. If instead there is a subsurface ocean underneath the crust, the wobble amplitude could be larger by an order of magnitude. If the crust is thin, a resonance between the seasonal and Chandler wobble further increases the polar motion amplitude and makes the polar motion path elliptical. However, the external and internal coupling and the elastic restoring torque owing to Titan's triaxial shape strongly counteract the polar motion.

Keywords: Titan, polar motion

PPS001-08

Room:101

Time:May 27 10:15-10:30

Investigations of the thermospheric dynamics of H_2 and H_3^+ in Jupiter

Takeru Uno^{1*}, Takeshi Sakanoi¹, Chihiro Tao², Yasumasa Kasaba¹

¹Tohoku Univ., ²ISAS/JAXA

There have been many attempts to observe the Jovian thermospheric temperature with varying degrees of success. Early spectroscopic studies (e.g., Kim et al., 1990; Ballester et al., 1994) focused on the determination of the mean H_2 and H_3^+ temperatures or the vertical thermal structure in the northern and southern auroral regions. From high spectral resolution 2 μ m imaging observation, Raynaud et al., 2004 showed that the spatial distribution of the emission from H_2 and H_3^+ aurora are morphologically different. The origin of this morphological difference is still unknown. It potentially suggests the difference of emission altitude or the difference of energy injection to and the energy transfer between the neutral and plasma atmospheres.

We have studied this region by numerical simulations (e.g., Tao et al., 2009) and have compared them with multiple wavelength observation data of infrared aurora (2-4 μ m) taken with a ground-based telescope. In addition to the emission distributions, we focus on the temperature and wind velocity information to investigate neutral-ion coupling in the Jovian upper atmosphere: How and where does the energy input occur into the neutral and plasma upper atmospheres?

In Sep.-Oct. 2010, we conducted two observations using IRTF/CSHELL and SUBARU/IRCS. The IRTF/CSHELL observations were performed on Sep. 17, 19 and 26. Two different lines were observed alternatively, i.e., H_2 $S_1(1)$ 2.12 μ m and H_3^+ $Q(1,0-)$ 3.953 μ m. The slit was positioned at the northern/southern polar region perpendicular to Jovian rotational axis. The high spectral resolution of CSHELL ($R = 43,000$) enable us the measurement of the line-of-sight velocity of H_3^+ and H_2 .

Simultaneous H_2 and H_3^+ observations near 2.1 μ m took place on Oct. 12 using the SUBARU/IRCS. The slit is set along rotational axis (vertical to the auroral main oval) at northern/southern pole. In the polar region, H_2 emission lines $S_1(0)$, $S_1(1)$, and $S_1(2)$ at the wavelengths of 2.22, 2.12, 2.03 μ m and several $H\{3\}^+$ emission lines are detected. The wide spectral coverage and the high sensitivity of SUBARU/IRCS enable us the rotational/vibrational temperature measurement from the simultaneous observation of the distribution of emission lines.

We will report the difference in the spatial distributions of the emission, temperature, and line-of-sight velocity of neutral and plasma atmosphere, derived from the data of those observations.

Keywords: Jupiter, thermosphere, temperature, ionosphere, Infrared, spectroscopy

PPS001-09

Room:101

Time:May 27 10:45-11:00

A dynamo driven by zonal jets at the upper surface: applications to giant planets

Philippe CARDIN^{1*}, Celine GUERVILLY¹, Nathanael SCHAEFFER¹

¹ISTerre, Grenoble, France

We present a new possible dynamo mechanism for generating the magnetic fields of the giant planets. The mechanism relies on the presence of barotropically unstable differential rotation. We assume that zonal jet currents within the outer molecular hydrogen layer exert a drag at the top of the deep electrically conducting region. Because of the rapid rotation of the planet, this boundary forcing drives nearly geostrophic axisymmetric motions in the conducting region. For a given forcing, measured by the critical Rossby number R_{oc} , a shear instability of the zonal flow develops in the form of a global Rossby mode. The wavenumber of the mode depends on the width of the zonal jets. For $Ro > R_{oc}$, we obtain self-sustained magnetic fields at magnetic Reynolds numbers greater than 103. The propagation of the Rossby wave and its nonaxisymmetric structure are both crucial for dynamo action. The amplitude of self-sustained axisymmetric poloidal magnetic field plausibly depends on the wavenumber of the shear instability, and hence on the width of the zonal jets. For narrow jets, the poloidal magnetic field is dominated by an axial dipole (jovian type) whereas in the case of wide jets, the axisymmetric poloidal field is weak (neptunian type?).

Keywords: dynamo, Rossby waves, Shear layers

PPS001-10

Room:101

Time:May 27 11:00-11:15

Lightning and thundercloud observation in Jupiter by spacecraft and telescopes

Yukihiro Takahashi^{1*}, Mitsuteru Sato¹, Tetsuya Fukuhara¹, Yoav Yair²

¹Hokkaido University, ²Open University, Israel

Lightning discharge is an excellent tool to explore the planetary atmosphere as well as Earth based on the knowledge of the relationship between the atmospheric dynamics, especially the vertical convection, and electrical charge. It has been suggested for a decade that thunderstorms in Jovian atmosphere take important roles not only in the investigation of meteorology, which determines the large scale structures such as belt/zone and big ovals, but also in probing the water abundance of the deep atmosphere, which is crucial to constrain the behavior of volatiles in early solar system. We plan to make observation of thunderstorm activity based on lightning flash detection and cloud imagery using spacecraft and ground-based telescope. We would propose a very simple high-speed imaging unit onboard Jovian orbiter of EJSM, Optical Lightning Detector, OLD, optimized for detecting optical emissions from lightning discharge in Jupiter. OLD consists of radiation-tolerant CMOS sensors and two H Balmer Alpha line (656.3nm) filters. The different bandwidths of the filters enable us to estimate the depth of discharge. On the other hand, we also consider detecting the optical flashes using a ground-based 1.6 m reflector dedicated to planetary observation, which was installed at Nayoro, Hokkaido, this year by Hokkaido University. Here we introduce strategies to observe lightning optical emissions by this telescope with narrow-band high speed imaging unit. Continuous monitoring with such a ground-based facilities make it possible to compare lightning activity with variations of large-scale motions, leading to the understanding of the dynamics of Jovian atmosphere.

Keywords: Jupiter, thunderstorm, lightning, spacecraft, telescope

Japan Geoscience Union Meeting 2011

(May 22-27 2011 at Makuhari, Chiba, Japan)

©2011. Japan Geoscience Union. All Rights Reserved.



PPS001-11

Room:101

Time:May 27 11:15-11:30

Polar Atmospheric Dynamics of Giant Planets

Kunio M. Sayanagi^{1*}, Jonathan L. Mitchell¹

¹University of California Los Angeles

Spacecraft observations of Jupiter and Saturn since the early 1970s have identified three distinct dynamical regimes in the cloud-top winds. In the equatorial region, a fast, broad jetstream blows eastward where no vortices are found. In the mid-latitudes of both Jupiter and Saturn, many vortices exist between the numerous jetstreams that alternate in wind direction between eastward and westward. Closer to the poles, vortices become increasingly prevalent with latitude; however, Jupiter and Saturn critically differ in their atmospheric dynamics around the poles. On Jupiter, poleward of approximately 65 degree N/S latitudes, the banded structure that characterizes the lower latitudes becomes indiscernible, and the flow acquires an increasingly turbulent appearance with little zonal organization – we identify this regime as polar turbulence. Saturn, on the other hand, maintains zonally organized cloud bands up to the poles and lacks polar turbulence. The zonal structure of Saturn culminates in the southern hemisphere with a hurricane-like cyclonic vortex residing precisely at south pole, and the northern jetstream at 77 degree N follows a meandering path that manifests as a hexagonal cloud morphology when viewed from above. We will present numerical experiments that address the polar jetstream phenomena on giant planets, and the mechanism that separates the polar atmospheric dynamics regime from the lower latitudes.

Keywords: Planetary Science, Atmospheric Dynamics, Jetstream, Turbulence, Jupiter, Saturn

Japan Geoscience Union Meeting 2011

(May 22-27 2011 at Makuhari, Chiba, Japan)

©2011. Japan Geoscience Union. All Rights Reserved.



PPS001-12

Room:101

Time:May 27 11:30-11:45

Seasonal and Temporal Variability of Jupiter and Saturn

Padma Yanamandra-Fisher^{1*}, Glenn S. Orton¹

¹NASA/JPL, ²NASA/GSFC

We report on the seasonal and temporal changes observed on Jupiter and Saturn, based on near- and mid-infrared data acquired from several observatories (NASA/InfraRed Telescope Facility, NAOJ/Subaru, ESO/Very Large Telescope) and provide compelling rationale for a coordinated network of large telescopes for continued ground-based observations. Jupiter has been experiencing an era of atmospheric global upheaval since 2005, the observed atmospheric changes being manifestations of changes in local meteorology and latent physical parameters of the system, and occur on various timescales and latitudes. The discrete storms in Jupiter's atmosphere have undergone significant changes over the past decade. The merger of the three white ovals into Oval BA and its subsequent color change in 2006 appear to be correlated to periodic interactions with the Great Red Spot (GRS). Subsequent episodes of GRS-Oval BA interactions in 2006, 2008 and 2010 provide snapshots of changes in the local meteorology. We identify relationships between latent physical variables of the spatially and temporally changing systems in terms of cloud opacities, aerosol distribution and thermal fields. The recent dramatic ongoing revival of the South Equatorial Belt (SEB) allows an unique insight into the dynamical processes that maintain belt/zone morphology. Ground-based near- and mid-infrared observations of Saturn from 1995 - 2009, covering half a Saturnian year, provide a rich data set to model seasonal changes in Saturn's atmosphere from autumnal equinox (1995) to vernal equinox (2009). Since 1995, as Saturn's south pole received increasing solar insolation, its albedo exhibits an increase in reflectivity at mid-latitudes in the southern hemisphere, decreasing towards the equator, anti-correlated with the thermal field. Similar to equatorial oscillations of temperatures on Earth and Jupiter, Saturn displays stratospheric temperature oscillations, with a period of half a Saturnian year, suggesting the influence of seasonal forcing. We anticipate development of similar phenomena in the next few years, as Saturn approaches northern solstice. Given the wealth of information from various spacecraft missions (Voyager, Galileo, Cassini) to both giant planets, many important questions remained unanswered, requiring continued exploration of these giant planets.

Keywords: Jupiter, Saturn, Atmospheres, Variability

PPS001-13

Room:101

Time:May 27 11:45-12:00

Design study of Jupiter X-ray imaging spectrometer on EJSM JMO

Yuichiro Ezoe^{1*}, Kumi Ishikawa¹, Takaya Ohashi¹, Tomoki Kimura², Atsushi Yamazaki², Kazuhisa Mitsuda², Masaki Fujimoto², Yoshizumi Miyoshi³

¹Tokyo Metropolitan University, ²ISAS/JAXA, ³Nagoya University

We present design and science study of the Jupiter X-ray imaging spectrometer as a payload candidate for the JMO (Jupiter Magnetospheric Orbiter) of EJSM (Europa Jupiter System Mission). EJSM is a joint international mission consisting of two flight elements developed by NASA and ESA to explore Europa and Ganymede, and one element by JAXA to observe the magnetosphere.

Jupiter is the most bright X-ray planet in the solar system. The current generation X-ray observatories (Chandra, XMM-Newton and Suzaku) have revealed various new aspects of Jovian X-ray emission. Jupiter's aurorae emit time variable X-rays via bremsstrahlung and charge exchange by energetic electrons and ions precipitation from the magnetosphere. Its low and middle latitude atmosphere exhibits scattering of solar X-rays. The diffuse X-ray emission seen in Jupiter's radiation belts suggests an inverse Compton scattering of tens MeV electrons. Io, Europa and Io Plasma Torus are also detected in X-rays. Hence, Jupiter and its vicinity is a reservoir of X-ray emissions. However, the low surface brightness and limited observation time hinder us to answer many basic questions such as what determines time variability of X-ray aurorae, what is the emission mechanism of Io, Europa, and Io Plasma Torus, and how necessary particles are accelerated and supplied in the radiation belts.

Driven by these scientific achievements and the remaining big puzzles, we have started to study design of an X-ray imaging spectrometer for EJSM JMO. Since JMO would allow high-latitude (10-30 deg inclination) measurements from large distances (>100 R_J), we can overview the whole Jupiter system in the X-ray band with an imaging and spectral capability. This in-situ measurement provides us with an unprecedented opportunity to observe Jupiter with extremely high photon statistics, time and angular resolution.

To realize the in-situ X-ray instrument for EJSM JMO, stringent mass and power limitations must be fulfilled. Also radiation and contamination of optical lights and debris must be taken care. The base line is a combination of an ultra-light weight X-ray telescope with the mass to area ratio of 10 kg/m², and an imaging detector with the pixel number of ~1000 and a low power less than several tens W. In this presentation, we present scientific goals, requirements on instruments, and current design candidates for the X-ray telescope and detector.

Keywords: Jupiter, X-ray, aurora, radiation belt, instrument

PPS001-14

Room:101

Time:May 27 12:00-12:15

Global ENA Imaging of the Magnetospheres of Saturn and Jupiter

Pontus Brandt^{1*}, Donald G. Mitchell¹, Barry H. Mauk¹

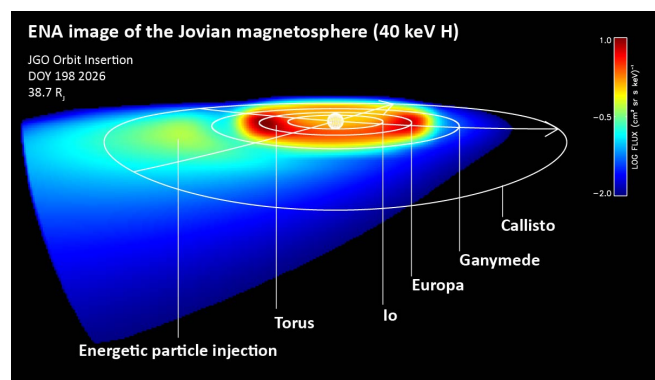
¹JHU/APL

Jupiter's magnetosphere is by far the largest object in the sky if it would be visible from Earth. Its stellar-like transfer of angular momentum from the fast rotating planetary magnetic field to the space plasma environment is the engine that makes the Jovian magnetosphere also the biggest planetary particle accelerator within the solar system. Dense plasma originating from the Io and Europa region loads the fast rotating planetary magnetic field, stretching it into a magnetodisk until a multi-step process involving magnetic field ruptures ("reconnection") and plasma instabilities accelerates ions and electrons up to 100 MeV that bombard the surfaces of moons.

EJSM has required a synergistic approach within the JGO-JEO constellation to unravel fundamental and universal magnetospheric processes such as these, by using powerful combinations of in-situ and global imaging measurement. The Japanese Space Agency is also considering a possible Jupiter Magnetospheric Orbiter (JMO), enabling triple point measurements and multi-point imaging to ensure simultaneous and continuous observations - a key requirement for revealing how the magnetosphere couples to the ionosphere as well as to the plasma sources.

Energetic Neutral Atom (ENA) imaging is so far the only technique capable of obtaining global images of the magnetospheric energetic ion population in the ~3-300 keV range, which otherwise would have remained invisible. ENA cameras on Cassini and the terrestrial IMAGE mission have revealed global, explosive acceleration processes and their connection to the ionosphere, aurorae and radio emissions. Therefore, the technique is considered to be game-changing and one of the required measurement techniques in the payload definition for both JGO and JMO.

We present how ENA imaging has revealed the global magnetospheric dynamics of Saturn in a way that would not have been possible with only in-situ measurements. With this background we discuss how ENA imaging can be used at Jupiter to explore global acceleration, MI-coupling, relation to aurorae and radio emissions, transport, solar wind control, constrain torus neutral gas evolution and provide global context for moon-magnetosphere interactions. We use past measurements and a data-derived model to simulate ENA images through a realistic camera response function along the JGO orbit and explore the scientific value added by in-situ and imaging measurements from JMO. The presentation is concluded by summarizing the critical technical requirements of ENA cameras, such as energy and mass range, geometrical factor and background/foreground rejection that must be met in order to operate in the harsh Jovian environment while achieving the highest priority science objectives.



PPS001-15

Room:101

Time:May 27 12:15-12:30

Dust-plasma interaction in Saturn's plasma disk

Shotaro Sakai^{1*}, Shigeto Watanabe¹, Michiko Morooka², Jan-Erik Wahlund²

¹Dep. CosmoSciences, Hokkaido University, ²Swedish Institute of Space Physics

Plasma in Saturn's magnetosphere is co-rotating due to the rapid rotation of the planet. The co-rotation speed can slow down due to, for instance, mass loading. Past observations by the particle detectors for few hundred eV ions showed that the plasma speeds are close to the ideal co-rotation speed around 5 R_s and gradually slow down to 20–30% of the ideal co-rotation at 7 R_s .

On the other hand, the Cassini observation using the Langmuir Probe (LP) showed that the ion bulk speeds are close to Keplerian in the E ring. The E ring of Saturn consists of small (micron- and nano- meter sized) dust grains. These dusts are negatively charged inside 7 R_s and expected to contribute to the electro dynamics in the plasma disk. Also near Enceladus, which is a major source of the E ring dusts, the electron densities are significantly smaller than the ion densities and the ion speeds are near Keplerian in a large region. Recently the Cassini Plasma Spectrometer (CAPS) onboard Cassini also observed that the sub-co-rotation of the ions can be slow down to 40–50% of the ideal co-rotation.

We statistically investigated the ion bulk speeds in the equatorial region of the inner magnetosphere using the Langmuir Probe (LP) onboard the Cassini spacecraft. The LP observation showed that the ion speeds are about 50% of the ideal co-rotation speed at 4 R_s and has a clear increasing trend with the distance from Saturn. Beyond 7 R_s the ion speed values are spread toward the ideal co-rotation speed. This can be due to that the sub-micron sized negatively charged the E ring dust contribute to the plasma dynamics in the plasma disk.

We have also calculated the ion speeds using the three components MHD equations including dust to investigate the effect of the ion-dust coulomb collision to the ion speed. Our models show that the ion-dust collision can reduce the ion acceleration by the co-rotation electric field when the ion-dust collision frequency is comparable to the ion cyclotron frequency. We indicate that magnetospheric electric field may be also important for the dust-plasma interaction in Saturn's plasma disk.

In this presentation, we compare results of our model with the Cassini/LP observation and discuss the dust-plasma interaction in the plasma disk of Saturn. We also discuss based on our results that future exploration to Saturn plays very important roles in planetary sciences.

Keywords: Saturn, E ring, Dusty Plasma, Dust-plasma interaction, Exploration of Saturn

PPS001-16

Room:101

Time:May 27 12:30-12:45

Plan for Observing Jupiter's Magnetosphere using the EUV Spectrograph Onboard the Sprint-A/Exceed Mission

Fuminori Tsuchiya^{1*}, Ichiro Yoshikawa², Masato Kagitani¹, Kazuo Yoshioka³, Naoki Terada¹, Yasumasa Kasaba¹, Go Murakami², Kouichi Sakai², Tatsuro Homma², Atsushi Yamazaki⁴, Tomoki Kimura⁴, Munetaka Ueno⁴

¹Tohoku University, ²The University of Tokyo, ³Rikkyo University, ⁴ISAS, JAXA

The EXCEED mission is an Earth-orbiting extreme ultraviolet (EUV) spectroscopic mission and the first in the SPRINT series being developed by ISAS/JAXA. EUV spectroscopy is suitable for observing tenuous gases and plasmas around planets in the solar system (e.g., Mercury, Venus, Mars, Jupiter, and Saturn). One of the primary observation targets is Jupiter, whose magnetospheric plasma dynamics is dominated by planetary rotation. In the EUV range, a number of emission lines originate from plasmas distributed in Jupiter's inner magnetosphere. The EXCEED spectrograph is designed to have a wavelength range of 55-145 nm with minimum spectral resolution of 0.4 nm, enabling the electron temperature and ion composition in the inner magnetosphere to be determined. The spectrograph slits have a field of view of 400 - 140 arc-seconds and an onboard target guide camera is used to stabilize attitude fluctuations to within 5 arc-seconds. With a large primary mirror (diameter: 20 cm) and high detection efficiencies (1-3%), EXCEED will measure Io plasma torus emission distributions with a good signal-to-noise ratio using an exposure time of 50 minutes and achieving spatial resolution of 20 arc-seconds. The previous observation of plasmas in the inner magnetosphere and the aurora with an EUV spectrograph was done by the Cassini spacecraft over a period of a few months. We re-examined the data obtained by the UVIS instrument to clarify the scientific objectives for the EXCEED mission. The UVIS observation sometimes showed sudden brightening in both the aurora and the Io plasma torus with a timescale from several hours to a few tens of hours. From the re-analysis of the UVIS data as well as radio waves (Cassini/RPWS) and the interplanetary magnetic field (Galileo/MAG) data, we found that the brightening events were related to a large-scale structure in the solar wind. However, because the Cassini observations had a lack of continuity due to the intermittent observation mode, it is difficult to make a definitive relation between the aurora and the plasma emissions in the inner magnetosphere. EXCEED plans to observe the variations in the aurora and in the radial structures of plasma emissions and should reveal the relationship between them in detail. The EXCEED observations are expected to investigate the radial plasma and energy transport processes in the rotation-driven magnetosphere.

Japan Geoscience Union Meeting 2011

(May 22-27 2011 at Makuhari, Chiba, Japan)

©2011. Japan Geoscience Union. All Rights Reserved.



PPS001-P01

Room:Convention Hall

Time:May 27 14:00-16:30

Towards EJSM (Europa Jupiter System Mission) in 2020s

Sho Sasaki^{1*}, Masaki Fujimoto², Takeshi Takashima², Hajime Yano², Yasumasa Kasaba³, Jun Kimura⁴, Yukihiro Takahashi⁴

¹National Astronomical Observatory, ²ISAS/JAXA, ³Tohoku University, ⁴Hokkaido University

Europa Jupiter System Mission (EJSM) is an international mission to explore and Jupiter, its satellite and environment. EJSM consists of (1) The Jupiter Europa Orbiter (JEO) by NASA, (2) the Jupiter Ganymede Orbiter (JGO) by ESA, (3) the Jupiter Magnetospheric Orbiter (JMO) studied by JAXA. They will be launched in 2020.

Together with plasma instruments on board JEO and JGO, JMO will investigate the fast and huge rotating magnetosphere to clarify the energy procurement from Jovian rotation to the magnetosphere, to clarify the interaction between the solar wind the magnetosphere. JMO will clarify the characteristics of the strongest accelerator in the solar system. JMO will investigate the role of Io as a source of heavy ions in the magnetosphere. Using multiple flybys with Callisto, we can enhance the inclination of JMO up to 50 degree. Then, high latitude regions of Jupiter can be observed from the spacecraft. Also we can obtain valuable information such as interior structure of Callisto, through the multiple encounters.

JAXA is studying solar power sail for deep space explorations following a successful ion engine mission HAYABUSA. This is not only a solar sail (photon propulsion) but also include very efficient ion engines where electric power is produced solar cells within the sail. An engineering mission IKAROS (Interplanetary Kite-craft Accelerated by Radiation Of the Sun) was launched and operated successfully in 2010. A mission with a large (100m-scale) solar power sail can transfer a large spacecraft to Jovian system. We are studying a mission to Jupiter and one (or two) of Trojan asteroids, which are primitive bodies with information of the early solar system as well as raw solid materials of Jovian system.

Keywords: Jovian Magnetosphere, Exploration of Jupiter, Icy satellites, Trojan asteroids, Europa, Callisto

PPS001-P02

Room:Convention Hall

Time:May 27 14:00-16:30

Proposal for the survey of Enceladus by high energy neutrinos

Daigo Shoji^{1*}, Kei Kurita¹, Hiroyuki Tanaka¹

¹Earthquake Research Institute

Enceladus is a small icy satellite of Saturn orbiting between Mimas and Tethys. In 2005 Cassini has identified characteristic surface features at the south pole of Enceladus such as high albedo and paralleled lineaments called 'tiger stripes', which emanate vapor plume [1]. These features suggest that Enceladus has young and active surface around the south pole region. On the other hand, at the north pole, Enceladus has surface whose albedo is lower than the south pole. Such asymmetry of the surface has aroused strong interests on the internal structure as well as its evolution as the origin.

To investigate the surface layer of Enceladus, electrical conductivity is an important information to constraint for the internal structure. Electrical conductivity depends on primarily on temperature [2]. If we can determine the value of conductivity, we can specify the property of ice such as temperature distribution of icy layer. In this presentation we propose a new method to determine the electrical conductivity of ice layer by detecting the radio waves induced by interaction between cosmic neutrino and ice.

When cosmic neutrinos flying in the outer space traverse through Enceladus, Cherenkov radiation induced by the weak interaction of neutrino with Enceladus is emitted. Radiations whose frequency is between a few hundreds of MHz and a few GHz (radio wave) become coherent and have such strong intensity that orbiting probe can detect. The number of detectable emissions depends on attenuation level of radio wave. The attenuation level of water ice can be approximated as $A = 0.0009s$ (dB/m) where A and s are attenuation level and electrical conductivity (in $\mu\text{S/m}$) respectively [3]. Thus, if we can count the number of emissions and determine their intensity level, electrical conductivity and temperature can be estimated. Since radio waves induced by neutrino interaction come from subsurface area of icy layer (~ 10 km in depth) local temperature distribution can be obtained by latitude-dependent summation for the emission in polar orbits.

To evaluate this method, we have performed a simulation about interaction of neutrinos with the icy layer and obtained that the number of detectable number of emissions and the shape of intensity distribution changed with the electrical conductivity of the layer. The strong point of this method is the passive detection of radio wave. Further more, accurate determination of electrical conductivity can make the rader system inspect the inner structure more precisely. We consider this radio detection method can be an useful tool to constrain the subsurface temperature of Enceladus.

References

- [1] Porco et al. (2006), Cassini Observes the Active South Pole of Enceladus, *Science*, 311, 1393-1401
- [2] Corr et al. (1993), Radar absorption due to impurities in Antarctic ice, *Geophys. Res. Lett.*, 20, 1071-1074
- [3] Moore (2000), Model of Rader Absorption in European Ice, *Icarus*, 147, 292-300

Keywords: Enceladus, neutrino, electrical conductivity, temperature, passive detection

PPS001-P03

Room:Convention Hall

Time:May 27 14:00-16:30

Whistler-mode chorus enhancements and anisotropic electrons in the Jovian inner magnetosphere

Yuto Katoh^{1*}, Fuminori Tsuchiya², Yoshizumi Miyoshi³, Akira Morioka², Hiroaki Misawa², Ryo Ujiie², W. S. Kurth⁴, A. T. Tomas⁵, N. Krupp⁶

¹STPP, Grad. Sch. Sci, Tohoku Univ., ²PPARC, Grad. Sch. Sci., Tohoku Univ., ³STEL, Nagoya Univ., ⁴University of Iowa, ⁵GeoForschungsZentrum Potsdam, ⁶Max Planck Institute

We reveal a close relationship between enhancements of whistler-mode chorus and development of energetic electron anisotropies in the Jovian inner magnetosphere by conducting a statistical survey of both wave and particle observations of the Galileo spacecraft. We studied the spatial distribution of intense chorus emissions in the Jovian magnetosphere and identified 104 chorus enhancements by analyzing plasma wave data in the frequency range from 5.6 Hz to 20 kHz obtained from the entire Galileo mission in the inner Jovian magnetosphere during the time period from December 1995 to September 2003. Enhanced chorus emissions with integrated wave power over 10^{-9} (V/m)² were observed around the magnetic equator in the radial distance range from 6 to 13 R_J. A survey of energetic particle data in the energy range of 29 to 42 keV reveals that all of the identified chorus events were observed in the region of pancake pitch angle distributions of energetic electrons. Using empirical plasma and magnetic field models, we estimate that the ratio of the electron plasma frequency to the electron cyclotron frequency in this region is in the range from 1 to 10 which is suitable for efficient whistler-mode wave generation. The present study reveals the statistically significant correspondence between intense chorus and flux enhancement of energetic electrons having pancake pitch angle distributions in the Jovian magnetosphere.

Keywords: Jovian inner magnetosphere, whistler-mode waves, energetic electrons, Galileo observations

PPS001-P04

Room:Convention Hall

Time:May 27 14:00-16:30

Development of the electronics for an infrared camera with InSb array

Takuya Kitami^{1*}, Takeshi Sakanoi¹, Takeru Uno¹, Takashi Ichikawa¹, Yasumasa Kasaba¹

¹Graduate School of Science, Tohoku Univ

We present the current status of development of the electronics on our infrared imaging camera with InSb 256x256 array. Infrared remote sensing of planetary atmosphere is one of the most powerful measurement tools to understand the dynamical and chemical processes in the atmosphere since there are many emission and absorption lines in the near-infrared range (1-5 μm), and the solar flux becomes smaller compared to visible range. Further, it is essential to carry out continuous measurement with our own instrument since it is necessary to clarify the time variation of those phenomena with long-term data. In particular, we aim to clarify the Jupiter's H_3^+ auroral response to solar wind variation with statistical approach. We are therefore developing our own 1-5 μm infrared

imager. This imager has a 256x256 InSb array detector, a field of view is 110arcsec with a F12 telescope with a plate scale of 0.43arcsec/pixel. In the case of 3.4 μm Jovian H_3^+ auroral measurementg, we estimate S/N of the acquisition of data to be about 33 with 1 minute exposure using 60cm/F12? telescope.

In this presentation, we focus on the electronics to control the detector.

Functions of the electronics are summarized as follows. [1] Generating the timing of three kinds of clocks, selecting horizontal vertical lines and reading the frame of the detector. [2] Converting it into the voltage that adjusted an above clock timing to the detector. [3] Constant voltage (Bias) generation . [4] The amplification of the detector output, and A/D conversion.

To satisfy the function [1] we adopt the digital circuit system with FPGA (Field-Programmable Gate Array) and one-board computer which had a characteristic of incorporated Linux. Concerning on the functions [2] [3] [4], the analog circuit system are used .

This camera will be installed on the 60 cm telescope of Iitate observatory, Tohoku University, and other overseas facilities, and used to monitor the Jupiter's H_3^+ aurora.

PPS001-P05

Room:Convention Hall

Time:May 27 14:00-16:30

Non-MHD Aspects of Ganymede's Magnetosphere: Investigation of Polar Wave-Particle Interaction Based on Galileo's data

Tomoki Kimura^{1*}, Satoshi Kasahara¹, Masaki Fujimoto¹

¹JAXA/ISAS

Jovian satellite Ganymede has small magnetosphere with characteristic scale lengths comparable to those of Mercury: e.g., size of the solid body, spatial expansion of the magnetosphere, and electron/ion gyroradii of ambient plasma. Comparative study of Ganymede's magnetosphere with Mercury will provide insights on the process universally existing in small planetary magnetospheres.

Basic characteristics of Ganymede's magnetosphere were revealed based on in-situ measurements by Galileo spacecraft during six encounters. Williams et al. (1997a, b, 1998, 2001, 2004) investigated particle dynamics (e.g., loss and pitch angle diffusion) in Ganymede's magnetosphere based on energetic electron/ion observations. Gurnett et al. (1996) and Kurth et al. (1997) indicated that Ganymede's magnetosphere is emitting radio and local plasma waves similar to planetary magnetospheres. Recently, global configuration of the magnetosphere and interaction with Jovian magnetosphere are also intensively investigated based on MHD simulations (Jia et al., 2009, 2010). However, non-MHD characteristics of Ganymede's magnetosphere have not been discussed in detail yet. For example, wave-particle interactions, ion kinetics, and polar field aligned particle accelerations.

This study addresses wave-particle interaction process in the polar cap region based on multi-instrumental observations during Galileo G02 flyby. Observations of high and low frequency wave, particle energy spectra, and pitch angle distribution revealed two kinds of magnetospheric regions: one where strong particle anisotropy by satellite surface loss is accompanied by electron and ion-related electromagnetic waves, and the other where there are weak surface interactions with electrostatic electron wave and no ion-related waves. The latter region corresponds to the ion upflow region (Jia et al., 2009) and locates near the open-closed boundary region of Ganymede's magnetosphere. We found that ion-related low frequency waves have significant energy flux into the Ganymede's polar ionosphere which is comparable to Jovian magnetospheric electron's energy input. This suggests the polar ionospheric heating by the energy from ion-related waves and subsequent ion upflow.

Keywords: Jupiter, Ganymede, magnetosphere, wave, energetic particle

Japan Geoscience Union Meeting 2011

(May 22-27 2011 at Makuhari, Chiba, Japan)

©2011. Japan Geoscience Union. All Rights Reserved.



PPS001-P06

Room:Convention Hall

Time:May 27 14:00-16:30

Modeling of infrared auroral emission from Jupiter and Saturn and its applicability for observation data analysis

Chihiro Tao^{1*}, Sarah V. Badman¹, Takeru Uno², Masaki Fujimoto¹

¹ISAS/JAXA, ²Tohoku Univ.

Aurorae represent plasma environments around a planet. Outer planetary aurorae are observed in various wavelength from radio emission, infrared (IR), visible, ultraviolet, to X-ray. Since IR wavelength is observable from the ground with spatial information, it would be good tool for monitoring to investigate the variable environment. Recent observation by Cassini spacecraft provides spatially-resolved Saturn's IR auroral image. Since the IR emission relates with thermally excited H_3^+ ion, it reflects atmospheric temperature in addition to ionization by auroral electron and solar EUV. Previous modeling study relates the IR emission and H_3^+ column density and atmospheric temperature. This study newly attempts to test its applicability for monitoring not only atmospheric condition but also auroral electron. We investigate the dependence of IR emission spectrum on temperature and electron energy spectrum using an IR emission model accounting for ionization by auroral electron with various energy flux, ion chemistry, and H_3^+ non-LTE effects. IR emission increases with increasing electron energy for <10 keV and then decreases. This decrease reflects low temperature at low altitude and hydrocarbons which reduces H_3^+ by dissociative recombination. Emission line ratio varies by a few 10s% depends on electron energy and by a factor depends on atmospheric temperature. We will discuss its applicability to observed data analysis and requirement for observations.

Keywords: Jupiter, Saturn, infrared, aurora, spectrum