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

PPS001-P01 Room:Convention Hall Time:May 27 14:00-16:30

Towards EJSM (Europa Jupiter System Mission) in 2020s

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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

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Proposal for the survey of Enceladus by high energy neutrinos

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

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

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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 reveal 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

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Development of the electronics for an infrared camera with InSb array

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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 um), 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 1-5um 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 3.4um Jovian H3+ 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 Jupter's H_3^+ aurora.

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

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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

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

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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