EPSC Abstracts
Vol. 6, EPSC-DPS2011-767-1, 2011
EPSC-DPS Joint Meeting 2011

Magnetospheric Science Targets of JMO

C. Tao (1), M. Fujimoto (1), Y. Kasaba (2), T. Kimura (1),Y. Ezoe (3), M. Kagitani (2), H. Tadokoro (2), Y. Miyoshi (4), S. Kasahara (1), T. Takashima (1), and the JMO working group
(1) ISAS/JAXA, Japan, (2) Tohoku University, Japan, (3) Tokyo Metropolitan University, Japan
(4) Nagoya University, Japan
(tao@stp.isas.jaxa.jp / Fax: +81-42-759-8456)

Abstract

Jupiter Magnetospheric Orbiter (JMO) is aimed to explore the Jupiter system in the framework of the Europa Jupiter System Mission (EJSM). In this presentation, we introduce recent orbital deliberation and science targets.

1. Introduction

Jupiter is the biggest gas planet in the solar system. Jovian magnetosphere is characterized as a strong accelerator and rotation-dominant environment. These are due to strong magnetic field, the fast planetary rotation, and the heavy plasma supply from the moon Io. In this harsh environment embedded are several moons including Europa that is supposed to be possibly habitable and Ganymede that hat its own magnetosphere.

JMO(Jupiter Magnetospheric Orbiter) is aimed to explore the Jupiter system in the framework of the Europa Jupiter System Mission (EJSM). EJSM is proposed to consist of Jupiter Europa Orbiter (JEO) and Jupiter Ganymede Orbiter (JGO). The goal is to characterize the processes within the Jupiter system, with the possibility that the Jupiter system may harbor habitable worlds in mind.

2. Goals of JMO

Science targets of JMO are (1) Huge system of fast-rotating intense magnetic field, (2) Giant particle accelerator, and (3) Electromagnetically dynamic binary systems. Through this exploration, we proceed to deepen our understanding of the plasma universe.

By synergetic observation with JEO and JGO, JMO also explores (4) Galilean satellites embedded in the highly variable harsh radiation environment to contribute Astrobiology research. Below we focus on magnetospheric exploration.

3. Background

3.1 Jovian magnetospheric exploration

Pioneer and Voyager brought plenty of discoveries through their flyby observations. The first planetary orbiter at a planet other than Earth, Galileo, established statistical features of magnetospheric dynamics and detailed in-situ observation around moons. New Horizons explored deep tail region. Latitude-scanning trajectory of Ulysses provided high-latitude information. JUNO is planned to explore Jupiter along polar orbits to investigate detailed auroral feature, atmospheric dynamics, gravity, and dynamo. As a next step beyond the JUNO mission that has an element of magnetosphere-ionosphere coupling studies, in-situ high-resolved observation in the magnetosphere would be strongly desired to investigate origin and formation of observed phenomena systematically.

3.2 Outer planetary exploration

Recent spectacular progress concerning outer planetary magnetospheres has been brought by Saturn spacecraft Cassini. Cassini has been unveiling rotation-dominant planetary environment of Saturn's uniqueness through in-situ high-resolved observation ranging from equatorial to high-latitude and imaging observation of aurora and energetic neutral atoms (ENA). Regulated by the planet's rotation, plasma cloud is injected from dawn tail and rotates around the planet. When the plasma cloud is located in the dawn region, radio and auroral activity increase. The magnetic field is also varies with rotation period despite the little tilt angle of the magnetic axis from the rotation axis. In addition, periodicity of magnetic field and radio emission differs between north and south. It is far beyond our image before exploration. It is desirable to clarify what happens in the more rotation-dominant and stronger accelerator of Jupiter.

3.3 Required/prefer observation

The following two observation modes should maximize outputs of magnetospheric exploration:(1) Equatorial in-situ observation for the investigation of the source region of plasma phenomena and acceleration site, and (2) High-inclined orbit for auroral and magnetospheric imaging and for remote sensing of radio emission to look down at phenomena globally and systematically.

4. Orbital plan

In order to achieve joint observation with JEO and JGO, JMO is planned to launched in 2022 and to arrive at Jupiter in 2027. Orbit transfer enabling the two-mode observation listed in section 3.3 is possible via gravity assist of Callisto. There are various options and trade-off points in choosing the exact orbits.

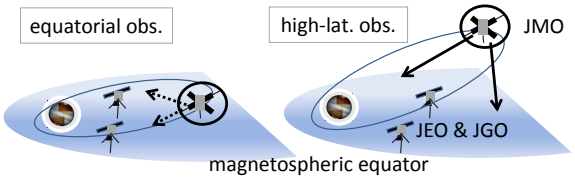

Figure 1. JMO orbits

5. Targets

The followings are potential main targets under discussion.

5.1 Magnetosphere in-situ

・Particle acceleration associated with reconnection
・ Role of plasma-neutral-dust interaction and magnetic turbulence on plasma transport and magnetosphere-ionosphere coupling
・Plasma injection and interchange process
・Particle acceleration and deceleration

5.2 Magnetosphere imaging

・Global activity of Jovian magnetosphere through ENA variation, substorm-like event, and injection
・Dynamical activity and energy budget of Io torus, and effect on global structure and other phenomena

5.3 Planetary imaging : aurora

・Global feature (polar, main oval, and low-latitude emission) and variation of aurora
・Occurrence and distribution of polar spot aurora which is considered to be related with reconnection
・Open-closed boundary and its variation

5.4 Remote-sense obs.: radio emission

・“Imaging spectroscopy” of energetic electron by radio : temporal and spatial evolutions of source location, spectra, beaming, and wave mode of each radio component
・ Statistics of radio characteristics (beaming, propagation, ...) by latitudinal scan
・Test on radio emission as a proxy of solar wind monitor and application

5.5 Imaging Spectroscopy obs. : X-ray

・ Imaging and spectroscopy of relativistic electron/ion in polar cusp, radiation belt, plasma torus, and magnetopause
・Monitoring of solar flare and ion bombardment on moons

5.6 Synergy effect

・JMO UV+IR+X+ENA +radio observation relating from magnetosphere to ionosphere
・JMO with JEO and JGO : variation of the moon’s space environment caused by activity in the outer-magnetosphere, multi-point observation (in-situ multipoint, in-situ and imaging conjugation) , and ENA/torus tomography (multiple view points)

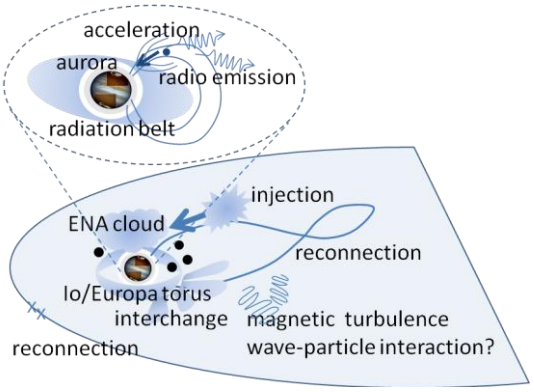

Figure 2. Schematics of JMO targets

6. Summary

In order to clarify the Jupiter's characteristics as a rotation-driven high energy accelerator and moon-Jupiter binary system, JMO is planned to explore (1) in-situ obs. in the magnetospheric equator, and (2) high-latitude obs.