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

PPS02-P01 Room:Convention Hall Time:May 24 17:00-19:00

The first observation of the altitude distribution of Jovian near-IR auroral emission using SUBARU/IRCS with Adaptive Op

UNO, Takeru[1*], SAKANOI, Takeshi[1], TAO, Chihiro[2], KASABA, Yasumasa[1], SATOH, Takehiko[2]

[1]Tohoku Univ., [2]ISAS/JAXA

The altitude emission profile is very important to understand that why the spatial distribution of the IR emission from H_2 and H_3^+ are morphologically different (e.g., Raynaud et al., 2004). The origin of this morphological deference is still unknown. It may be caused by the difference of heating altitude and/or difference of precipitation energy.

Although the altitude distribution of IR auroral emission of H_2 and H_3^+ is well discussed by the theoretical model (e.g., Kim et al., 1990; Grodent et al., 2001), observational study is limited. The observation of vertical distribution of H_3^+ column density and vibrational-rotational temperature are only reported by Lystrup et al., 2008. And there is no vertical-resolved observation of H_2 emission.

Based on the model calculation, it is thought that the difference of IR emission altitude between H_2 and H_3^+ is about 500-1000 km (Grodent et al., 2001). It is impossible to detect this vertical difference by ground-based observation, because the typical seeing of 0.6 arcsec is corresponding to the vertical resolution of about 1800 km at the Jupiter. The recent technique of Adaptive Optics (AO) makes it possible to get the high spatial resolved data about 0.1 arcsec, corresponding to the vertical resolution of about 300 km.

Simultaneous H_2 and H_3^+ observation near 2.1 um took place on 30 Nov. 2011 using the SUBARU/IRCS with AO188 system. The slit is set along rotational axis (vertical to the equator) at northern pole. Using Europa for the guide star for AO system, we succeeded the first limb observation of Jupiter H_2 and H_3^+ IR auroral emissions.

In the polar region, H_2 emission lines S1(0), S1(1), and S1(2) at the wavelengths of 2.22, 2.12, 2.03 um and several H_3^+ emission lines are detected.

We will report the difference in the spatial and vertical distributions of those emissions and temperatures, derived from the observation.

Acknowledgement: Based on data collected at Subaru Telescope, which is operated by the National Astronomical Observatory of Japan.

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

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

PPS02-P02 Room:Convention Hall Time:May 24 17:00-19:00

Modeling micro structure of Jovian S-bursts

MITSUDA, Shota[1*], RYABOV, Vladimir[1]

[1]Future University Hakodate

Jupiter is known as the strongest source of decametric (DAM) radio emissions in the Solar system. The emissions occur during events called radio storms lasting from tens of minutes to few hours. The radio storms are well predictable, since their occurrence correlates well with certain range of Jupiter rotation phases and orbital positions of Jovian innermost moon Io. The control of radio emissions from Io can be explained by the combination of such factors as strong Jovian magnetic field, fast rotation of Jupiter (much faster than that of Io's orbital motion) and presence of plasma along Io's orbit sputtered by numerous volcanoes on its surface.

Crossing of Jovian magnetic field lines by Io causes about 400 kV voltage across the moon by electromagnetic induction that leads to acceleration of electrons in its vicinity. The electrons perform cyclotron motion propagating along magnetic field lines towards Jupiter. As they approach Jupiter, some of them are reflected at corresponding mirror points due to increasing value of the magnetic field. However, part of electrons that penetrates deeply into Jovian atmosphere is lost due to collisions that leads to a deficit of certain pitch angles in the electron distribution of the upstream and can pump electromagnetic waves to grow by the cyclotron maser instability (CMI) mechanism.

The above macroscopic picture explains many observational features of DAM emissions, but does not account for complex morphology of time -frequency patterns often present in spectrograms. First, the emissions can be roughly divided into two classes called S- and L-bursts, depending on their characteristic time scales: order of seconds for L(Long) ones and order of milliseconds for S(Short) ones. Furthermore, spectrograms of S-emission events present us with perplexing variety of spectral patterns, from simple linearly drifting in frequency bursts to extremely complicated shapes, which can hardly be interpreted within a framework of a simple CMI model.

An attempt to look at S-bursts with sub-microsecond time resolution had been performed in [1,2] aimed at understanding the very basic details of the emission mechanism. It had been suggested in [2] that two classes of models, of amplifier and generator type, can serve as prototypes of linear wave growth and saturated plasma wave instability, correspondingly. The final conclusion of paper [2] derived from the analysis of several simple linearly drifting bursts stated that only the former mechanism could account for the observed characteristics of S-bursts. It remains, however, unclear whether such type of model can be used for explaining the generation mechanism of other, more complicated bursts, as well as whether linear wave growth is never saturated in simple linearly drifting bursts.

In this work, we perform a more systematic study of the Jupiter radio emission waveforms recorded at world largest DAM array UTR-2 on March 15, 2005, with the purpose of validating the amplifier model for a larger set of S-bursts with different properties. First, we analyze several simple linear S-bursts and search for waveform segments with apparent saturation that could be attributed to generator model (Fig.1). We attempt then to interpret the found segments with amplifier model all the same. For this purpose, we perform a numerical simulation of amplifier-type signals trying to reconstruct the found saturating waveforms. Finally, we interpret such waveform segments in terms of characteristic time of autocorrelation function and fluctuating instantaneous bandwidth in the selected S-bursts. We also present the analysis of several S-bursts displaying a complex pattern in the time-frequency plane checking for its consistency with the amplifier-type model.

References

[1] Carr, T. D., and F. Reyes, JGR 104, 25127 (1999).
[2] V. B. Ryabov et al., JGR 112, A09206 (2007).

Keywords: Jupiter, S-bursts, cyclotron maser, amplifier, generator, filter

PPS02-P02 Room:Convention Hall Time:May 24 17:00-19:00

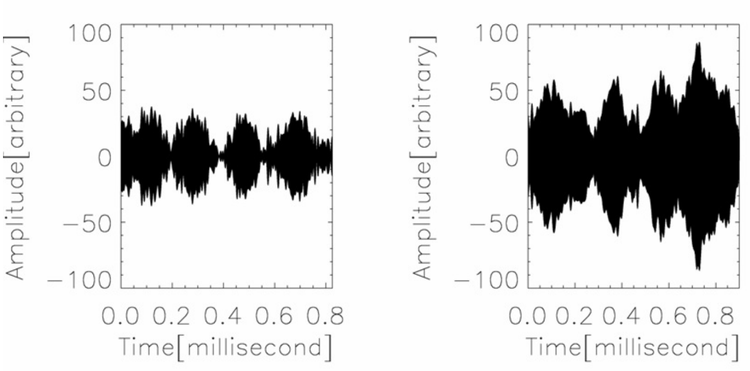

Fig 1. Examples of S-bursts: waveforms of amplifier (left) and generator (right)

PPS02-P03 Room:Convention Hall Time:May 24 17:00-19:00

Titan's degassing history constrained by the isotopic ratio and abundance of Ar in the atmosphere

HONG, Peng[1*], SEKINE, Yasuhito[1], CHO, Yuichiro[2], SUGITA, Seiji[1]

[1]Complexity Sci. & Eng., Univ. of Tokyo, [2]Earth & Planetary Sci., Univ. of Tokyo

The volatile inventory on Titan is a key parameter to reconstruct the evolution of its atmosphere-surface system and climatology. The Cassini spacecraft has revealed the absence of a large liquid CH_4 reservoir on the surface and the presence of radiogenic ^{40}Ar in the atmosphere, suggestive of recent degassing from the interior. However, the timing and magnitude of degassing remain largely unknown. Knowledge on volatile releases from the interior into the atmosphere since its accretion is also essential to understand the thermal history, interior structure, and early evolution of Titan.

Here, we focus on the abundance and isotopic ratio of Ar in the atmosphere to constrain the degassing history of Titan. The abundances and isotopic ratios of Ar in the atmospheres of Earth and Mars have been used to constrain their degassing histories (e.g., Hamano & Ozima, 1978; Tajika & Sasaki, 1996), because of both its inertness and the lack of radiogenic ^{40}Ar in the early solar system. We have developed a degassing model of Titan's atmosphere based on that of Earth's atmosphere (Ozima, 1975). We calculated the time evolution of the amounts of primordial ^{36}Ar and radiogenic ^{40}Ar both in the atmosphere and interior of Titan. In the interior, ^{36}Ar and ^{40}Ar were assumed to be homogeneously distributed. We assumed that the initial abundances of ^{40}K and ^{36}Ar in Titan's rock component were same as those of the average abundances of CI chondrites ([^{40}K] = 0.77 ppm, [^{36}Ar] = 1.25 ppb) (Mazor et al., 1970; Lodders, 2003). We also assumed that the ice component was initially free of primordial ^{36}Ar. We did not consider the escape of atmospheric Ar. The following two extreme cases were considered for the degassing history; (1) continuous degassing through Titan's history and (2) episodic degassing, in which releases of volatiles from the interior occurred episodically in Titan's history (e.g., Tobie et al., 2006).

On the basis of comparison with the observations, we found that the calculated present atmospheric ^{40}Ar/^{36}Ar ratios cannot reproduce the observations (^{40}Ar/^{36}Ar = 106-295, Niemann et al., 2010) for either continuous or episodic degassing. In the case of continuous degassing, the calculated present atmospheric ^{40}Ar/^{36}Ar ratio reaches only 39. Even in the case of episodic degassing, the ^{40}Ar/^{36}Ar ratios become less than 56, which is the calculated present 40Ar/36Ar ratio in the interior 4.55 billion years after the solar system formation.

There are two possibilities to account for the observed atmospheric ^{40}Ar/^{36}Ar ratio and abundance of ^{40}Ar in Titan's atmosphere: (1) More than 60% of primordial ^{36}Ar initially contained in the rock components had escaped in the early history of Titan, or (2) the distribution of ^{40}K in the interior was heterogeneous, and ^{40}K was concentrated in cryomagma $>$ 2.6 times that of CI chondrites in the early stage. Either explanation would require a large-scale interior melting and/or consequent formation and loss of proto-atmosphere (Kuramoto & Matsui, 1994). These conclusions suggest that the accretion time of Titan would be much shorter ($< 10^6$ years) than the prediction by the gas-starved model for the circumplanetary subnebula (Canup & Ward, 2006; Barr et al., 2010) and that Titan's interior would have been differentiated (Fortes, 2012), rather than mixtures of ice and rock components (Iess et al., 2010).

Keywords: Titan, degassing, rare gas, icy satellite, evolution of atmosphere