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

PPS02-P01 会場:コンベンションホール 時間:5月24日 17:00-19:00

SUBARU/IRCSと補償光学を用いた木星近赤外オーロラ発光の高度分布観測
The first observation of the altitude distribution of Jovian near-IR auroral emission using SUBARU/IRCS with Adaptive Op

宇野 健[1*], 坂野井 健[1], 垰 千尋[2], 笠羽 康正[1], 佐藤 毅彦[2]
UNO, Takeru[1*], SAKANOI, Takeshi[1], TAO, Chihiro[2], KASABA, Yasumasa[1], SATOH, Takehiko[2]

[1] 東北大学・理・地球物理, [2] 宇宙航空研究開発機構宇宙科学研究所
[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 会場:コンベンションホール 時間:5 月 24 日 17:00-19:00

Modeling micro structure of Jovian S-bursts
Modeling micro structure of Jovian S-bursts

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

[1]Future University Hakodate
[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).

キーワード: Jupiter, S-bursts, cyclotron maser, amplifier, generator, filter
Keywords: Jupiter, S-bursts, cyclotron maser, amplifier, generator, filter

PPS02-P02 会場:コンベンションホール 時間:5 月 24 日 17:00-19:00

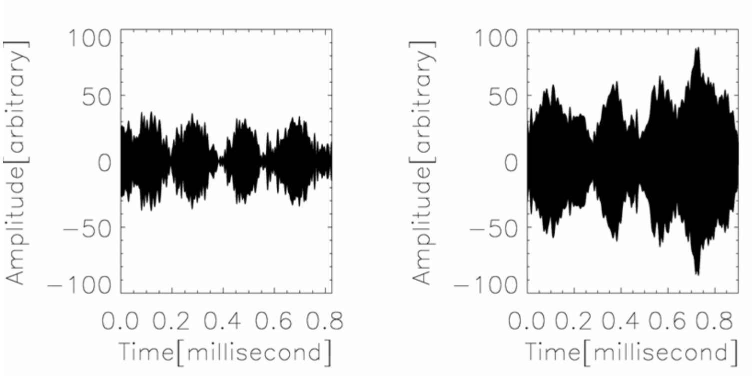

Fig 1. Examples of S-bursts: waveforms of amplifier (left) and generator (right)

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

PPS02-P03 会場:コンベンションホール 時間:5 月 24 日 17:00-19:00

大気中のアルゴン量と同位体比から制約するタイタン脱ガス史
Titan's degassing history constrained by the isotopic ratio and abundance of Ar in the atmosphere

洪 鵬 [1*], 関根 康人 [1], 長 勇一郎 [2], 杉田 精司 [1]
HONG, Peng[1*], SEKINE, Yasuhito[1], CHO, Yuichiro[2], SUGITA, Seiji[1]

[1] 東京大学 複雑理工学専攻, [2] 東京大学 地球惑星科学専攻
[1]Complexity Sci. & Eng., Univ. of Tokyo, [2]Earth & Planetary Sci., Univ. of Tokyo

タイタン地表面の揮発性成分量の変遷を明らかにすることは、大気表層進化や気候システムの理解にとって重要である。近年のカッシーニ探査によって、タイタン地表面に大規模な液体 CH_4 の海が存在しないこと、また放射性 ^{40}Ar が多く大気中に存在することが明らかになったことは、比較的最近に内部からの脱ガスがあった可能性を示唆するが、その時期や規模はほとんど分かっていない。内部からの脱ガスの時期や、現在の状態を説明するための必要条件を明らかにすることは、タイタンの熱史や内部状態、初期進化に対しても重要である。

本研究ではタイタン大気の脱ガス史を制約するため、大気中の ^{40}Ar と ^{36}Ar の存在量とその同位体比に着目した。Ar は化学的に安定であり、^{40}K の壊変でできる ^{40}Ar は太陽系初期にはほとんど存在しなかったと考えられるので、地球型惑星の脱ガス史の制約に広く用いられてきた (e.g., Hamano & Ozima, 1978; Tajika & Sasaki, 1996)。本研究では地球の Ar 脱ガスモデル (Ozima, 1975) に基づき、タイタン大気の脱ガスモデルを立てた。大気と固体の 2 つのボックスを考え、それぞれのボックス内での ^{36}Ar 量と ^{40}Ar 量の時間進化を計算した。固体には岩石と氷が含まれ、^{36}Ar と ^{40}Ar は固体中で均質に分布していると仮定した。初期状態として、岩石中の ^{40}K と ^{36}Ar 濃度は CI コンドライトの平均値 ([^{40}K] = 0.77 ppm, [^{36}Ar] = 1.25 ppb) (Mazor et al., 1970; Lodders, 2003) を用い、氷には ^{40}K と ^{36}Ar は含まれないと仮定した。また脱ガスした Ar は散逸せず、全て大気中に留まるとした。固体から大気への脱ガス量は固体ボックス内の Ar 量と脱ガス率の積として表し、脱ガス率の時間変化は (1) タイタン形成時から一定（連続脱ガス）、または (2) ある時点で大規模な脱ガスが起きる（間欠脱ガス）(e.g., Tobie et al., 2006)、という 2 種類の極端な場合を考えた。

その結果、連続脱ガスと間欠脱ガスのどちらの場合であっても、現在の大気中の ^{40}Ar/^{36}Ar 比 (106 - 295, Niemann et al., 2010) を説明できないことがわかった。連続脱ガスを仮定した場合、現在の大気中の ^{40}Ar/^{36}Ar 比は 39 となり、^{36}Ar が ^{40}Ar に比べて 3 倍程度過剰に存在してしまう。また、間欠脱ガスを仮定した場合、現在の大気中に存在する全ての Ar がごく最近に脱ガスしたとしても、大気中の ^{40}Ar/^{36}Ar は 56 でしかなく、やはり ^{36}Ar が ^{40}Ar に比べて 2 倍程度過剰に存在する。これはタイタン固体部分の ^{40}Ar/^{36}Ar 比が太陽系の形成から 45.5 億年経ても最大で 56 にしかならず、現在の大気中の ^{40}Ar/^{36}Ar 比に達するほど上昇しないためである。

現在の大気中の ^{40}Ar/^{36}Ar 比を説明するためには、(1) 比較的初期において、^{36}Ar の 60%以上がタイタンから散逸すること（間欠脱ガスの場合）（連続脱ガスの場合は ^{36}Ar の 75%以上）、または (2) 脱ガス源となる氷マグマ中の ^{40}K 濃度が CI コンドライトに対して 2.6 倍以上高いこと（間欠脱ガスの場合）（連続脱ガスの場合は 4.2 倍以上の濃集）、という条件が必要である。(1) の場合は、集積中に ^{36}Ar が大規模に脱ガスし、それが後に力学的に散逸したという可能性を示している (Kuramoto & Matsui, 1994; Lammer et al., 2008; Sekine et al., 2011)。一方、(2) については、初期にタイタン内部が融解することにより (Kuramoto & Matsui, 1994)、可溶性の ^{40}K が岩石成分から内部海に濃集し、^{40}Ar/^{36}Ar 比の高い氷マグマ源を形成したという可能性を示す。これらのことは、(1)(2) のいずれの場合でも、形成初期における大規模融解・脱ガス過程が必要であることを示しており、タイタンの形成時間が、一般的な円盤集積モデル (Canup & Ward, 2006; Barr et al., 2010) で予想されるよりも短く (e.g., $< 10^6$ year)、またタイタン内部もこれまで考えられていたような未分化状態ではなく (Iess et al., 2010)、分化している可能性が高いこと (Fortes, 2012) を示唆している。

キーワード: タイタン, 脱ガス, 希ガス, 氷衛星, 大気進化
Keywords: Titan, degassing, rare gas, icy satellite, evolution of atmosphere