

「ひさき」衛星による惑星間空間のヘリウム分布光学観測

Optical observation of neutral helium distribution in interplanetary space by Hisaki

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ひさき (SPRINT-A) 衛星は長期間継続した惑星観測を行うことが主目的であるが、観測好機となる惑星が存在しない時期には惑星以外の観測も実施している。そのうちの一例が、惑星間空間からのヘリウム原子共鳴散乱光観測である。

惑星間空間には、局所星間空間(LISM)の物質が太陽圏と星間物質の相対速度による星間風により、ヘリオポーズを超えて太陽圏内に侵入している。イオン化エネルギーが高いヘリウム原子はイオン化することなく太陽近傍の0.5Au程度まで侵入することができる。その軌道は太陽重力によって曲げられ、太陽の星間風下側に密度の濃い領域を形成する。これをヘリウムコーンと呼ぶ。惑星間空間のヘリウム分布から星間風の速さと方向、星間空間ヘリウム原子の密度と温度を推定することができる。このような研究は1970年代から実施されているが、近年のIBEX衛星がより精密に観測を実施した。その結果から星間風の方向が数十年かけて徐々に変化していることが報告された(Frisch+13)。

ひさき衛星もヘリウムコーンからのヘリウム原子共鳴散乱光観測を実施した。今年は、ヘリウムコーンの密度が極大経度を含む2ヶ月間に渡り連続して観測した。惑星間空間からのヘリウム共鳴散乱光観測結果を報告し、星間風の速度方向の変化について議論する。

キーワード：惑星間空間ヘリウム、極端紫外光観測、星間風

Keywords: Interplanetary helium, EUV observation, Interstellar wind

ChubuSat-2衛星による太陽中性子の観測

Solar neutron observations with ChubuSat-2 satellite

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Solar neutron observation is a key in understanding of ion acceleration mechanism in the Sun surface since neutrons are hardly affected by magnetic field around the Sun and interstellar mediums unlike charged particles. However, there was only a few tenth detections so far since its discovery in 1982. Actually SEDA-AP Fiber detector (FIB) onboard the International Space Station (ISS) was suffered from a high neutron background produced by the ISS itself.

ChubuSat is a series of 50-kg class microsatellite jointly developed by universities (Nagoya university and Daido university) and aerospace companies at the Chubu area of central Japan. The ChubuSat-2 is the second ChubuSat following the ChubuSat-1 which was launched by Russian DNEPR rocket on November 6, 2014. It was selected as one of four piggyback payloads of the X-ray astronomy satellite ASTRO-H in 2014 summer, and will be launched by the H-IIA launch vehicles from from JAXA Tanegashima Space Center (TNSC) in February 2016. The ChubuSat-2 carries a mission instrument,

radiation detector (RD). The main mission of ChubuSat-2 is devoted for monitoring neutrons and gamma-rays which can be background source for ASTRO-H celestial observations with the RD. The mission also involves a function of solar neutron observations which were originally proposed by graduate students who join the leadership development program for space exploration and research, program for leading graduate schools at Nagoya University. The RD has a similar detection area and efficiency to those of the SEDA-AP FIB, but is expected to have lower background than the ISS thanks to much smaller mass of the micro-satellite. In this paper, we will describe details of ChubuSat-2 satellite and RD, and in-orbit performance of RD.

キーワード：太陽、中性子、衛星観測

Keywords: Sun, Neutron, Satellite observations

太陽電波II型バーストのスペクトル微細構造の統計的出現特性

Statistical characteristics of spectral fine structures in solar radio type II bursts

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Type II bursts are one of the solar radio bursts associated with flare and coronal mass ejections (CMEs). They are thought to be a plasma emission from non-thermal electrons accelerated in and/or around a shock wave. A type II burst appeared as a group of spectral fine structures with the typical duration of a few hundreds msec is reported recently [e.g. Sato et al. in the JpGU2014 meeting]. Such spectral fine structures can be interpreted as the motion of non-thermal electron beams accelerated in the shock region.

In this study, we performed a statistical analysis to investigate generality of spectral fine structures of type II bursts by using the meter wave band solar radio telescope AMATERAS developed by Tohoku University [Iwai et al., 2012]. AMATERAS enables us to observe solar radio bursts in the frequency range between 150 and 500 MHz with the 10 msec accumulation time and 61 kHz bandwidth. We identified occurrence of totally 13 type II bursts for the period of Oct. 2010 to Sep. 2014, which were all associated with solar flare events. As the result, we revealed that all of them were accompanied by spectral fine structures. This fact strongly suggests a possibility that the spectral fine structures are general characteristic of type II bursts. The drift rates of the spectral fine structures were analyzed for all type II events. It is found that they showed both positive and negative senses and were in the time scale of tens to hundreds MHz/s. By assuming a general coronal plasma density model, for example the Newkirk model [Newkirk, 1961], particle speeds for some fine structures are estimated to be unrealistically high; i.e., faster than the light speed. The drift rates are faster than those of the well known spectral fine structure in type II burst 'herringbone structure', therefore, it is notable that the spectral fine structure identified in this study is a 'newly identified type' in type II bursts. And the unrealistically high drift rate implies the existence of denser plasma structure than general coronal plasma possibly near the shock regions. In the presentation, we will show the general characteristics of the fine structures of type II bursts and also discuss possible source regions.

キーワード：太陽II型バースト、スペクトル微細構造

Keywords: Solar type II burst, spectral fine structure

フレアの規模とIII型バーストの出現特性の関係

Relationship between solar flare level and occurrence characteristics of type III bursts

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太陽電波III型バーストは、太陽面の爆発現象であるフレアに伴う突発的な電波放射である。出現周波数はGHz帯からkHz帯まで広範囲におよび、周波数の高い方から低い方へ向かって大きな負の周波数ドリフトを持つ。磁気リコネクションによって加速された電子ビームが開いた磁力線に沿って上昇し、周辺のプラズマを伝搬する際にプラズマ波(ラングミュア波)を励起し、そのプラズマ波が電磁波に変換されたものと考えられている。一方、磁力線に沿って下降する粒子は、彩層の高密度プラズマに突入して制動放射し、そのエネルギーで熱せられた彩層プラズマがコロナループを満たすことで軟X線を発生する。太陽フレアの際に緩やかに上昇して観測される軟X線フラックスは、フレア的全エネルギーを表す指標と考えられ、フレアの大きさを表す指標として一般的に用いられている。以上のように、III型バーストとX線の放射はフレア発生時の磁気リコネクションの発生が関与していると考えられ、両者の間には高い相関関係があることが想定される。

本研究では、東北大学の太陽電波望遠鏡AMATERASで観測されたメートル波III型バーストの出現とGOES軟X線フラックスの時間変化との比較を行い、両者の関係の精査を試みた。この結果、大きな軟X線フレアによって発生するIII型バーストと同じような特徴(大きな負の周波数ドリフトを持ち、同じような周波数帯で発生)をもつバーストが、フレアが観測されていないときにも多く出現することが分かった。このことは、軟X線フレアとしては認識されないものの、粒子加速に寄与する過程が起きていることを示唆する。本研究は、大規模なフレアに伴って放射される場合と、軟X線のフラックスの変動の少ない場合の両者について、III型バーストのスペクトルの特徴、バーストの強度、発生場所について統計的に解析することで、電波発生に関わる粒子の加速過程の条件を明らかにすることを目的として行っている。

本講演では、特にAMATERASで2014年に観測されたIII型バーストの解析に基づき、軟X線フレアの有無とIII型バーストのスペクトル構造と強度の関連性について報告を行うとともに、粒子加速過程について議論を行う予定である。

キーワード：電波バースト、フレア、粒子加速

Keywords: radio burst, flare, particle acceleration

Decrease of magnetic field strength in the forenoon solar wind for parallel IMF

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Interaction between the lunar surface and incident solar wind is one of the unsolved problems of the lunar plasma sciences. The Kaguya (SELENE) measurements revealed that about 1 percent of incident solar wind protons are scattered at the lunar dayside surface and re-picked up by the motional electric field to affect the ambient solar wind as well as the lunar wake. However, few studies have been performed for the parallel IMF case, except for wave observations by ARTEMIS spacecraft. Here we show an event where strength of the IMF decreases at 100 km altitude on the lunar dayside when the IMF is almost parallel to the incident solar wind flow, comparing the upstream solar wind data from ACE and WIND with Kaguya magnetometer data. The lunar surface below the Kaguya orbit is not magnetised, and the upward-going protons show signatures of those scattered at the lunar surface. We find that the decrease in the magnetic pressure is compensated by the thermal pressure of the back-scattered protons. We note that the observed phenomena are to some extent similar to those of bow-shock reflected ions in the terrestrial foreshock and may generally take place as a result of interaction between solar wind and non-magnetised body.

Keywords: Solar wind - Moon interaction, Interplanetary magnetic field, Kaguya (SELENE), Proton scattering

Hybrid simulations on the acceleration of pickup ions via the pump mechanism
Hybrid simulations on the acceleration of pickup ions via the pump mechanism

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Generation process of high energy particles, far beyond the background thermal energy, has been one of the key topics in space plasma physics. Acceleration by their interaction with shock waves is the major mechanism, where a power-law spectrum is derived in the energy distribution. The standard shock acceleration theory shows that the power-law index depends on the shock compression ratio. In contrast, in-situ plasma measurements by ACE, Ulysses, and Voyager spacecraft recently identified that particles in the heliosphere have a common spectrum in the suprathermal range (the order of tens to hundreds of keV), where $f(v) \sim v^{-5}$, indicating that the shock waves do not play a dominant role in particle acceleration. The pump acceleration proposed by Fisk and Gloeckler [e.g., 2014] is one of alternative mechanisms to account for the generation of this common spectrum. In this study, we verify the validity of this pump process by performing two-dimensional hybrid simulations including interstellar pickup ions. We demonstrate several parameter sets and identify the strong dependence of acceleration efficiency on the angle between the solar wind flow direction and the magnetic field, as well as the spatial scale of compression/expansion structures in the pump process. We confirm the formation of the power-law tail in the velocity distribution of pickup ions, where the shock is not the only site of acceleration. We will discuss the diffusion property of energetic particles within the pump structures in comparison with the theoretical description.

キーワード：粒子加速、太陽風、ピックアップイオン

Keywords: particle acceleration, solar wind, pickup ion