Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

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Development of the solar-planetary environment studies based on inter-planetary comparisons

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The sphere of influence of the planet, from the planetary surface to the vicinity space, is referred to as a ”planetosphere”. How this planetosphere has been evolved in response to the evolution of the sun is one of important outstanding problems. Closely related to this question, researches of the solar evolution, planetary atmospheric outflows, and planetary meteorology, are rapidly in progress. In this presentation, we introduce a plan of researches and infrastructure development for them to apply our knowledge about the current geosphere to studies of planetospheres based on inter-planetary comparison. In this study, interdisciplinary studies to apply our knowledge of planets in our solar system to exoplanets are also promoted. In addition, it is planned to promote the study of the evolution of the sun. For this purpose, we utilize new observations by MOA, MAVEN, ALMA, Hisaki, Akatsuki, BepiColombo, and JUICE. A unique approach for the exoplanet search and solar wind estimation at planetary orbits in cooperation with 3D heliosphere project also consist of important parts of this study.

Keywords: planet, exoplanet, solar wind, evolution, solar-planetary system, interdisciplinary

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Radiocarbon dating of ancient Japanese document and calligraphy

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1. Introduction

The purpose of this study is show that radiocarbon dating is a useful method to determine written age of ancient Japanese document and calligraphy. Therefore, we measured radiocarbon ages of ancient documents, sutras and books of known age by accelerator mass spectrometry (AMS).

Kohitsugire are ancient paper sheets or fragments containing elegant calligraphy. They were originally pages of ancient manuscripts. The old manuscripts written before the 14th century hardly remain as complete books; therefore, kohitsugire potentially has high academic value. However, among kohitsugire attributed to famous calligraphists, many copies and counterfeits written several centuries later are in circulation. Therefore, in this study, we measured radiocarbon ages of kohitsugire by AMS. In the first, we measured ancient documents, sutras and books of known age for check of the method. Then, we applied to kohitsugire calligraphies of unknown age to determine their historical ages and academic value.

2. Experimental

Paper samples were cut from the margins of ancient document or kohitsugire. A kohitsugire is commonly mounted on other paper sheets that form a lining. The samples were soaked in distilled water to peel the surface sheet of the calligraphy from the mounts. The surface sheets were first washed in distilled water with an ultrasonic cleaner and then treated with 1.2N HCl and 1.2N NaOH solutions (60-70^{o}C). After re-treating with 1.2N HCl and rinsing with distilled water, they were combusted using CuO (850^{o}C, 3h) to form CO_2. The CO_2 was reduced to graphite by H_2 (650^{o}C, cat-Fe, 6h). The radiocarbon ages were measured by AMS.

3. Results and discussion: the known-age documents

The results of the known-age documents, sutras and books were plotted on the calibration curve. The obtained radiocarbon ages of the documents correspond to the paleographical ages. Although ancient Japanese paper can be considered as a wooden sample, it was made from short-lived branches of trees. In addition, old paper is not used for calligraphy because it repels India ink and is unsuitable for elegant handwriting. The result indicates that ancient Japanese paper is suitable for radiocarbon dating.

4. Results and discussion: kohitsugire calligraphies

We applied to kohitsugire of unknown age to clarify their historical ages and academic value. An example is kohitsugire attributed to Nakatomi no Kamatari (614-669). However, radiocarbon dating indicated that it was written in the 14th century and is not his genuine handwriting.

Ganjin(688-763) is a priest of China. He brought Japan many Buddhist sutra, Buddha statues, medicine and spice in 753. Especially an important thing is the Shibunritsu sutra of 60 volumes which described commandments and organizational operation of temple. At present, the Shibunritsu sutra of 16 volumes that are said for Ganjin to have brought are stored in Shosoin. Radiocarbon dating is destructive analysis. It, therefore, cannot be applied to Sutra stored in Shosoin directly. Kohitsugire is a fragment of ancient calligraphy. They were cut from an ancient book or roll of sutras. We obtained a kohitsugire considered to have been cut from Shibunritsu stored in Shosoin. Microscope observation and bibliographical consideration clarified that the kohitsugire is rightly fragment of the Shibunritsu stored in Shosoin. Radiocarbon dating of the kohitsugire indicated that it was written before the Ganjin visit to Japan. This result shows that possibility that the kohitsugire and Shibunritsu of Shosoin were brought by Ganjin is very high. This study using microscope observation, bibliographical consideration and radiocarbon dating indicated that indirectly radiocarbon dating can be applied for samples to which destructive analysis could not be originally applied.

Keywords: Histrical age, Ancient Japanese document, Ancient Japanese calligraphy, Radiocarbon Dating

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Laboratory and observational studies of properties of aerosols related to climate change

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Aerosol particles originated from a variety of natural and anthropogenic sources. Primary particles emitted directly to the atmosphere as liquids or solids, while secondary particle formed by nucleation and condensation of precursor gases as well as through reactions in cloud droplets. These particles influence Earth's radiation balance both directly by absorbing and scattering solar radiation and indirectly by acting as cloud condensation nuclei (CCN).

Black carbon (BC) is considered to be the most potent light absorbing material in the visible region of the spectrum. In addition, light absorbing organic carbon (brown carbon or BrC) may also act as sources of significant absorption, especially in the ultraviolet and shorter visible wavelength regions. The optical properties of such particles depend on wavelength, particle size, shape, morphology, and complex refractive index (or chemical composition). Recently, cavity ring-down spectroscopy (CRDS) and photoacoustic spectroscopy (PAS) have been used for direct in-situ measurements of extinction and absorption coefficients of particles suspended in air. We have applied these techniques to observational studies of optical properties of BC and BrC and to laboratory studies of optical properties of secondary organic aerosols (SOAs) generated from a variety of biogenic and anthropogenic volatile organic compounds and those of diesel exhaust particles.

Hygroscopicity is also an important property of aerosols to estimate their direct and indirect effects on the radiation balance. We have measured relative humidity dependence of extinction coefficients using a custom built two channel CRDS system to examine the hygroscopicity of aerosols. In addition, we have involved in several observation campaigns to detect new particle formation events, which have been recognized as an important processes contributing to CCN formation. These studies on the optical and physicochemical properties of aerosols have been conducted in collaboration with many groups in Japan. In this presentation, our recent studies will be overviewed and the future perspective on possible collaborations with other groups with different specialties will be discussed.

Keywords: Aerosol, Optical property, Hygroscopicity, New particle formation, Climate change

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New seamless science of hydrologic - biogeochemical cycles on the Earth surface

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Land - atmosphere interface on the Earth surface is where humans primarily operate. In the Anthropocene, human activities modify the land surface in many ways that influence the fluxes of water, energy, and trace gases between land and the atmosphere. Such land ? atmosphere interactions are primarily important for the current climate change. On the other hands, solar activity seems to have secondary effect for the long-term climate change in the Quaternary period including the Holocene. However, not much is known on the effect of solar activity to the climate change as well as precise mechanisms of solar - climate system in this period. In this presentation, we will discuss on how researches of hydrologic - biogeochemical cycles relate to those of climate changes induced by solar - human activities.

Keywords: hydrologic cycle, biogeochemical cycle, solar activity, human activity, climate change

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Importance of integrated data analysis in the Sun-Earth system science

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The Sun-Earth system including the solar atmosphere, interplanetary space, magnetosphere, ionosphere, and atmosphere have been studied with various kinds of observations. The satellite and ground-based observations have provided dynamical variations occurred in the Sun-Earth system. In spite of the abundant observational data being distributed recently, overall processes of the variations are not comprehensively understood until the integrated data analysis taking full advantage of using many kinds of the observation data is realized. So far, the integrated data analysis needs several steps to realize truly ubiquitous for the solar-terrestrial physics community. For example, gathering data files archived at different places in the world wide and combining the data in different formats is quite bothersome and could make researchers lose their motivation. However, the recent development of computer network makes it possible to access the online databases via the internet. The common data formats, such as FITS and CDF, have been increasingly popular in the recent data archives, which paves the way for the users to concentrate their efforts into the data analysis itself, without the detail knowledge of the file format. The Solar-Terrestrial Environment Laboratory (STEL), Nagoya University has started the Hinode science center in collaboration with ISAS/JAXA and NAO, and the ERG science center operated by STEL/Nagoya Univeristy and ISAS/JAXA. As one of the important functions for the science centers, we have developed and promoted the database with the standard data format and the integrated data analysis system to gain the science output through the integrated data analysis. Besides the observation data, it is essential to understand the phenomena quantitatively in combination with the simulation data, and the science centers have developed data-assimilation techniques and integrated analysis tools combining the simulation data. In this presentation, we show our activities at the Hinode/ERG Science center at Nagoya University and discuss the possible role of the science center as a leading center for the community projects.

Keywords: Sun-Earth System Science, integrated data analysis, ERG, Hinode

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Ground-Based Network Observations of the Upper Atmosphere using Optical and Radio Instruments

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We are carrying out routine observations of airglow using Optical Mesosphere Thermosphere Imagers (OMTIs) to investigate the dynamics of the mesosphere, thermosphere, and ionosphere at an altitude of 80-350 km. The OMTIs consist of five sky-scanning Fabry-Perot interferometers (FPIs), 13 all-sky CCD imagers, three tilting photometers, a spectral airglow temperature imager (SATI), and three airglow temperature photometers to measure two-dimensional airglow images and neutral winds and temperatures. The OMTIs are located at several key points around the world: Shigaraki, Rikubetsu, and Sata in Japan; Chiang Mai in Thailand; Darwin in Australia; Kototabang in Indonesia; Resolute Bay and Athabasca in Canada; Magadan and Paratunka in Russia, Tromsoe in Norway, and Hawaii in U.S.A. Using these OMTI instruments, we obtained various interesting results, e.g., finger-like aurora structures, concentric gravity waves expanding from the typhoon, and the characteristics of nighttime medium-scale traveling ionospheric disturbances in the vicinity of their equatorward boundary. We are planning to install all-sky imagers, FPIs, magnetometers, and GNSS receivers in Africa (Nigeria and Ethiopia) and Russian Far East for global observation of the upper atmosphere under the project of ”Coupling process in the solar-terrestrial system”. We also plan to install a VHF radar at magnetic equator in Thailand to study generation mechanisms of plasma irregularities. These studies could contribute to mitigation of ionospheric effects on GNSS and satellite communication.

Keywords: ionosphere, thermosphere, mesosphere, upper atmosphere, airglow, radar

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Seasonal variation of dead carbon fraction in dripwater in the Ryugashi Cave, Shizuoka Prefecture, Japan

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Stalagmite is a cave deposit precipitated from dripwater. Dripwater contains some dead carbon derived from carbonate-dissolved CO_2 through interaction with cave bedrock limestone, which will make the ^{14}C ages of the stalagmite older, and so a correction of the dead carbon fraction (DCF) is needed for ^{14}C dating of stalagmites. In this study, we investigated seasonal variation in ^{14}C in dripwater in the Ryugashi Cave, Shizuoka Prefecture, to examine the DCF stability in a stalagmite. The results show that ^{14}C concentration in dripwater was different depending on the site in the Ryugashi Cave, and that the ^{14}C showed similar seasonal variations at all sites: lower in fall and winter, while higher in spring and summer, though the extent of the seasonal variations was different by site. The ^{14}C concentration in dripwater tended to be higher (DCF tends to be lower) in dripwater with lower drip rate, indicating that the ^{14}C in dripwater was correlated with the drip rate, and also correlated with rainfall amount around the Ryugashi Cave.

A growing stalagmite collected from a site in the Ryugashi Cave showed a roughly constant DCF (around 12%) compared with the ^{14}C with the IntCal13 calibration curve, though the DCF was slightly fluctuated in detail. The results indicate that high-resolution ^{14}C measurement can be performed on stalagmites in the Ryugashi Cave, and further that the DCF fluctuation observed for stalagmites could give information on change of paleo-rainfall amount. Based on the scenario that the increase in rainfall amount brings the increase in drip rate of dripwater, followed by the increase in soil-derived carbon fraction in dripwater, further followed by the ^{14}C increase (DCF decrease) in dripwater, the reconstruction of precipitation could be performed using DCF variation in a stalagmite.

Keywords: dripwater, stalagmite, radiocarbon

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An attempt on 14C dating of carbonate hydroxyapatite in a cremated bone

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Bones are one of the most important materials for archaeological and paleo-environmental dating because they can directly provide absolute dates themselves. Bone collagen, which contains bone protein that is less susceptible to chemical weathering, is commonly used for ^{14}C dating, but it sometimes has lost organic protein due to post-depositional chemical alternation and diagenesis, resulting in impossibility of ^{14}C dating. For the bones remaining no organic component, carbonate hydroxyapatite, an inorganic component, is useful for ^{14}C-measurement. However, the inorganic component in bones can easily be altered by acidic soil, and it has been considered to be unsuitable for ^{14}C dating. Recently, meanwhile, it is reported that ^{14}C dating using carbonate hydroxyapatite is possible for cremation bones heated at a high temperature (>600 ℃). The objective of this study is to examine the possibility of ^{14}C dating using carbonate hydroxyapatite in cremated bones. The samples used were cremated bones in a funerary urn, which are considered to be remains of Jokei, a Buddhist monk (AD 1155-1213). The bones had been confirmed to be burned at high temperature, judged from the IR spectra and XRD patterns. The carbonate hydroxyapatite in six bone fragments showed ^{14}C dates of 1155-1280 cal AD, which is similar with the supposed age. The result indicates that ^{14}C dating using carbonate hydroxyapatite is effective when the bone sample was enough heated and well-preserved after deposition.

Keywords: bone, carbonate hydroxyapatite, radiocarbon dating

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Development of superconducting device for millimeter-wave atmospheric radiometer 1

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Division of Atmospheric Environment in Solar-Terrestrial Environment Laboratory, Nagoya University is operating the millimeter-wave atmospheric radiometers for long-term monitoring observation of ozone and related molecules of ozone depletion in the middle atmosphere. These monitoring systems are installed in Rikubetsu town in Hokkaido, Atacama highland in Chile, Riogallegos in Argentina, and Syowa station in Antarctica. In order to detect the emission from atmospheric molecules with high sensitivity, we use STJ (Superconducting Tunnel Junction) device which is constructed from SIS (Superconductor-Insulator-Superconductor) structure for receiver in the radiometers. From the last year, we have started the collaborative development of new STJ device for atmospheric radiometers with Advanced Technology Center, National Astronomical Observatory of Japan, because the research and development of the STJ device is extremely active in the area of radio astronomy. In this presentation, we describe the design, test production, and result of measurement properties in the laboratory of 100 GHz (wavelength ˜3 mm) band new device for observation of ozone molecular spectrum at 110 GHz.

The STJ device in 100 GHz band has been used in our radiometers as well as NANTEN2 radio telescope in Chile, 45-m millimeter wave telescope in Nobeyama, and so on. However, these receivers are used old design STJ devices and these performances are a little worse. For example, the receiver noise temperature and gain compression at ambient temperature are approximately 80 K and more than 10 %, respectively. It is necessary more high sensitivity and better linearity to detect and determine the brightness temperature of weak emission from minor molecules. Therefore, we designed the device with new structure based on previous work (Inoue, 2011), which performances to be about 20 K of noise temperature and about 1 % of gain compression, and also we have fabricated and tested five SIS junction array devices. As a result, we successfully developed low noise temperature (18-25 K) devices in 100 GHz band. We will measure the gain compression, performance of intermediate frequency, and stability of the output signal in the future, and we plan to practical use for the radiometers in Rikubetsu and Riogallegos.

Keywords: middle atmosphere, minor molecules, millimeter wave, radiometer, superconducting device, SIS mixer

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14C age calibration dataset based on tree rings from Japanese wood and its comparison with IntCal13

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Radiocarbon (14C) dating is widely applied to archeological materials and cultural properties that are sometimes closely related with historical events. In particular, 14C dating is utilized to decide whether the materials are really related with the historical events, and highly accurate dating of the samples is required to judge the real from the false for history-related materials. Accuracy of 14C dating results is determined largely by appropriateness in sample preparation and measurements of 14C abundance of the prepared targets, but it is also related with the procedures to obtain reliable calendar age in calibration of sample conventional 14C age. For 14C age calibration, the IntCal13 data sets are normally used for terrestrial samples whose carbonaceous fractions were synthesized from atmospheric CO2 in the Northern Hemisphere, while the SHCal13 data sets are used for those in the Southern Hemisphere.

The accuracy of calendar age that was obtained by calibration of 14C age with IntCal13 data sets (Reimer et al. 2013) is, however, sometimes questioned because of the possibility that 14C concentration in atmospheric CO2 may vary spatially (Imamura et al. 2007). The calibration data sets IntCal09 are established on the basis of 14C data for tree rings grown in North America and Europe, but do not include those for the tree rings grown in other areas, for example, in Japan, although 14C data for plant residues from the bored cores at Lake Suigetsu, Fukui Prefecture, Japan, will be incorporated in the age range of 11.2-52.8 ka BP in the latest calibration data sets (Bronk Ramsey et al. 2012). The Japanese archipelago is located at the eastern margin of the Asian continent in the middle or a bit lower latitude region, and the 14C concentration in atmospheric CO2 over Japan may be lower than that at inland areas and northern locations as in North America or Europe, as the result of CO2 release to the atmosphere from the near-by ocean surface which has a lower 14C concentration, or air-mass delivery over the Pacific Ocean by East Asian monsoon in summer season when the plants grow quickly.

To investigate the 14C concentration of atmospheric CO2 in the past few millennia over Japan, we measured 14C ages of annual rings on a single year basis from three Japanese trees whose calendar dates range from ca. 2000 years old to present, and compared the tree-ring 14C ages with corresponding 14C ages of IntCal13. It was revealed that 14C ages of annual rings from Japanese trees are not consistent with IntCal13 data sets. Many 14C ages of tree rings are older than those of IntCal13, but younger than those of SHCal13 data sets. The average shifts of Nagoya 14C ages from IntCal13 ones and one-sigma errors were obtained to be +26+/-36, +24+/-30, +16+/-22, +5+/-21 and +14+/-22 14C years, for the intervals of AD72-382, AD589-1072, AD1413-1615, AD1617-1739 and AD1790-1860, respectively. IntCal13 data sets are usually preferred for calibration of 14C ages from Japanese samples, but it is revealed that SHCal13, or maybe a modified intermediate version of IntCal and SHCal, is rather suitable for Japanese samples in some cases. The Japanese archipelago is situated near the boundary of the Inter-tropical Convergence Zone in summer season, and the 14C concentration of atmospheric CO2 over Japan can be influenced by air masses of the Southern Hemisphere with lower 14C concentrations during the period of higher solar activities and magnified East Asian summer monsoon. Our results suggest that the Japanese archipelago is located in the critical zone where it is difficult to calibrate the 14C ages of tree ring samples collected with existing calibration data sets. At the moment, it should be noted that calibration of 14C dates of Japanese samples with IntCal13 may induce additional systematic shifts of calibrated ages toward older ages by about 30 years, from the sample optimum calendar ages.

Keywords: radiocarbon age, dendro-date, calendar date, solar activity, Pacific high barometric pressure, ITCZ

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Acceleration of high-energy particles in geospace and influence of the energetic particles on the terrestrial atmosphere

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Geospace is filled with high-energy particles. Magnetic reconnection and wave-particle interaction such as whistler-mode wave play important roles to accelerate and produce the high-energy particles. Such high-energy particles enter the terrestrial atmosphere along the magnetic field lines through polar regions. The precipitated energetic particles heat up and ionize the upper atmosphere, leading to increase HOx and NOx components though ion chemistry in the thermosphere, mesosphere, and even in the upper stratosphere in some highest energy case. The HOx and NOx are well known as ozone depleting substances through catalytic chemical reaction cycle. If the enhanced NOx are transported down to the stratosphere due to the polar vortex, the life-time of NOx is extended and its influence on the terrestrial atmospheric environment is supposed to be not negligible. In this sense, the solar activity is seamlessly related to the terrestrial environment. In STEL, Nagoya University, we have launched a new project team for this issue. The aim of this project is to understand the fundamental processes of particle acceleration and chemical/dynamical interactions between the high-energy particles and atmospheric molecules based on satellite observations, ground-based observations, and numerical simulations. We will utilize ground-based meteor radar, millimeter-wave spectrometer, sky imager, sodium lidar, and satellite ERG in order to obtain a comprehensive view of the solar forcing on the terrestrial environment in connection with the high-energy particles. In addition, we will collaborate with UCLA and LASP/UBC to handle the dataset obtained by Van Allen Probes for radiation belt, THEMIS, MMS for magnetosphere, SDO for Sun under the framework of JSPS program for Advancing Strategic International Networks to Accelerate the Circulation of Talented Researchers. In this presentation, we will discuss more detailed plan and strategy of this project.

Keywords: particle acceleration, environmental change, Aeronomy, solar physics, atmospheric chemistry

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New perspectives of space weather forecast

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The study of space weather forecast has a great importance since numerous satellites are orbiting around the earth providing necessary infrastructure to our society, and also the international space station cruses around the earth carrying astronauts who conduct various observations and experiments in the space. To prevent accidents caused by such as spacecraft discharge, destruction of electronic devices by high-energy particles, radiation exposure of the astronauts, the study of the space weather forecast is quite significant.

In order to achieve this goal, it is necessary to conduct researches on explosive events such as CMEs or solar flares on the sun, the nonlinear evolution of the solar wind and a resultant shock formation, the interaction between the solar wind and the magnetosphere, the driving mechanisms of substorms and magnetic storms, production of high-energy particles in the inner magnetosphere. Also, various elementary processes associated with those phenomena, such as the magnetic reconnection, Kelvin-Helmholtz instability, the cyclotron instability, other various plasma instabilities, and interactions between waves and particles should be studied.

Currently, we are promoting the development of Geospace Environment Modeling System for Integrated Studies (GEMSIS) aiming at realizing an accurate space weather forecast at our division of STE laboratory as one of the flagship projects of the laboratory.

However, to make the forecast of the space weather far more accurate, it is necessary to accelerate the studies on the predictions of the solar wind evolution, the fluxes of the solar proton and cosmic rays, the auroral activity, the ring current intensity, the flux of radiation belt particles, and more fundamentally the solar dynamo, appropriately employing advanced technologies in statistical mathematics as well as super computing.

In the new division for integrated studies which will be constructed at the time of newly organizing the laboratory, we will try not only to establish firm and universal methods of space weather forecast, but also to make innovative findings and establish a new guiding principle in the field of space and earth environmental study.

Keywords: space weather forecast, sun, magnetosphere, geospace, elementary plasma process

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A plan of tree-ring isotopic analyses in Japan for SPE searching during the past 5300 years

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Tree-ring isotopic analyses has achieved remarkable technical innovation in recent years, and it's becoming capable of acquisition of high-resolution proxy data for explication of the universe global environment in the past. In this session, we show a plan of the tree-ring isotopic analyses of the Japanese tree during the past 5300 years for exploration range expansion of Solar Particle Event (in the following, SPE).

We established four floating chronologies during about 3700-5300 years ago using dendrochronology (based on ring-width) and radiocarbon dating in Japan. Composition wood samples of these chronologies are very valuable because the wood sample before 3000 years ago is very little in the northeast Asia including Japan.

We're planning oxygen isotope analyses for dendrochronological dating of these samples. Nakatsuka and Kimura has been building oxygen isotope master-chronology using the buried forest and the archeological woods, which has reached until about 4300 years ago recently. Our floating chronologies are overlapped about 600 years this master-chronology. Therefore when using oxygen isotope data for a parameter of the cross-dating, we expect a possibility that date of our chronology is decided.

We use sample to which a calendar date was decided for radiocarbon measurement. We get the proxy data which reconstructs solar activity in the past 5300 years by this measurement and consider the periodicity of SPE.

Keywords: tree-rings, oxygen isotopic ratio, SPE

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U06-P14 Room:Convention Hall Time:May 24 18:15-19:30

Cosmic-ray physics as a seamless science

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Cosmic rays are high-energy radiation flying in extra-terrestrial space. Particularly those coming from extra-heliosphere are called the galactic cosmic-rays and have a energy spectrum ranging over a broad region of 10^8 eV to 10^{20} eV. Among the galactic cosmic-rays, charged particles reach the earth being affected by magnetic fields in the space. The flux of charged particles with the kinetic energy less than 10 GeV/n are modulated by solar magnetic activity. The cosmic rays entering the earth's atmosphere interact with earth's atmospheric atomic nuclei and produce secondary particles called the air shower. For high energy region, by detection of air showers using various methods and comparison with simulation results, original particle energy and its species are determined. On the other hand, the secondary particles produce atmospheric ions through atomic-molecular interaction by ionization process, and then form atmospheric electric field and relate production of aerosol particles and cloud condensation nucleation.

Three subjects in the cosmic-ray study are (a) mechanism of acceleration and production, (b) nature of cosmic-ray particles themselves and (c) propagation and relation to the sun and the earth in neighboring environment. Here, two detailed topics connected from the space to the solar-terrestrial environment are introduced.

The frequency of cosmic-rays around the highest energy is less than 1 particle/km^2/year. Good statistical detection with such low frequency needs an extensive observation site. In the measurements of primary cosmic ray energy and nuclear species, florescence detection of air showers originated by cosmic rays and extended sampling detection of air shower particles at the ground are used together with simulations. However, particularly for ultra-high energy regions, hadron interaction models used in simulations have not yet verified and this uncertainty gives large systematic errors for determination of cosmic ray energy and species of nuclei. We are carrying out a verification experiment (LHCf collaboration) at LHC, which is a particle accelerator with the highest energy in the world. We have obtained good results up to the energy of 10^{17} eV equivalent with proton-proton collisions. In order to apply to the real air shower, collision experiments of proton-light nucleus (nitrogen, oxygen, etc.) and light nucleus-light nucleus to iron nucleus are needed.

Cosmic-ray particles entering the earth initiate nuclear interactions with atmospheric atomic nuclei and produce many secondary particles. These secondary cosmic-rays create atmospheric ions according to their ionization ability. It is considered that these ions promote the production and growth of aerosol particles, which become cloud condensation nuclei in the atmosphere. We are trying to verify the correlation between the time variations in the cosmic-ray intensity measured by neutron monitors at the ground and the earth's low-altitude cloud cover, by a chamber experiment with artificial radiation sources.

Cosmic rays reach the earth surface from the space far away through the heliosphere and the earth's atmosphere, and interact with each region. It is necessary to consider such broad regions connecting seamlessly.

We have conducted the study on elementary process on cosmic-ray interactions with earth's atmosphere and verification of its relation to global climate, and would like to clarify the seamless process through the cosmic-rays. In this talk, we introduce the details of these studies.

Keywords: cosmic ray, the sun, earth's atmosphere, hadron interaction, ion-induced nucleation

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Observational study of the solar wind expanding from the Sun beyond the Earth and to the interstellar medium

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All planets in our solar system are engulfed by a supersonic plasma flow from the Sun, called the solar wind, and make ceaseless interaction with the flow. In the case of the Earth which has a magnetic field, the magnetosphere is formed in its neighborhood, and the Earth's atmosphere does not directly interacts with the solar wind. Even for such a protected environment with the magnetic barrier, violent fluctuations of the solar wind cause significant influences on the near-Earth space environment and upper atmosphere. Since these influences sometimes endanger the space system and the social infrastructure including telecommunications, efforts to improve our understanding of physical processes in the Sun-Earth system are extensively made to enable reliable predictions (research for space weather forecast). In particular, precise understanding of the solar wind is crucial for achieving the space weather forecast. Effects by the solar activity is observed not only in the Earth's upper atmosphere but also in the near-surface environment, and some mechanisms which assume the solar wind plays a role to connect between them are proposed. The solar wind expanding beyond the Earth orbit encounters the interstellar medium, and causes intense interactions there. The region formed through this interaction, called the heliosphere, has a dimension as large as 100 AU. Recently, spacecraft (Voyager-1,2) reached the boundary of the heliosphere, and are providing in situ data in the unexplored region of the interstellar space. This boundary region of the heliosphere located far away is not disconnected with the Earth's environment. Namely, the large-scale structure of the heliosphere strongly influences the propagation of galactic cosmic rays coming to the Earth. Here, it should be noted that a drastic change of the solar wind is in progress being accompanied with the marked decline in the solar activity, and as the result the heliosphere is expected to shrink globally. Thus, one can clarify the hidden process in the Sun-Earth coupling by investigating the relation between the current solar activity and change of the Earth's environment. The solar wind observations using interplanetary scintillation (IPS) have been conducted over a long period at the Solar-Terrestrial Environment Laboratory of Nagoya University. Large-aperture UHF-band radio telescopes located at three observatories in Japan are used for the IPS observations, and obtained data enable accurate determination of global distribution of the solar wind. Number of collaboration studies with domestic and oversea researchers have been made using our IPS data, which are quite unique in the world space community. Three-dimensional properties of the heliosphere evolving drastically with the solar activity, propagation dynamics of disturbances associated with eruptive events, and enigmatic mechanism for the solar wind acceleration investigated through our collaboration researches. We intend to elucidate the solar wind variation caused by the peculiar solar activity and its influence to the Earth's environment from further IPS observations.

Keywords: solar wind, interplanetary scintillation, solar cycle, heliosphere, space weather

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Research of past solar activity by using cosmogenic nuclides

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Cosmogenic nuclides, such as ^{14}C and ^{10}Be, are produced by cosmic rays which enter to the Earth. These nuclides are accumulated in tree-rings and ice sheets, respectively. We can investigate the past cosmic ray intensity by measuring the content of these nuclides in archive samples. Also the content of the cosmogenic nuclides can figure out the past solar activity because the cosmic ray intensity to the Earth is modulated by the solar geomagnetic activity.

The IntCal dataset, which is a sequence of ^{14}C content data with 10-yr resolution for over this 10,000 years, shows the past solar activity. Yearly ^{14}C content data have also been examined, mainly for grand solar minima. From these annual ^{14}C content measurements, it has been suggested that the length of the Schwabe cycle increased during some grand solar minima. However, the Sporer Minimum does not show this negative correlation between the solar activity and the Schwabe cycle length. Then we need additional ^{14}C data for longer periods.

On the other hand, if a severe SPE (Solar Proton Event) had occurred in the past, it would be possible that the content of the cosmogenic nuclides increase suddenly with an increase of the incoming cosmic ray intensity with a short time. We found two such events in AD774-775 and in AD993-994 by an annual measurement of ^{14}C content. Also there are signatures of these cosmic ray events in the ^{10}Be concentration data. It is possible that a cause of these events is a severe SPE. If such events occur now, it inflicts heavy damage on modern society. Then, it is important to investigate an occurrence rate and a pattern of occurrence of severe SPEs, and we expect that annual ^{14}C measurement will figure out such things.

We are planning the annual ^{14}C content measurement for this 10,000 years using Japanese wood samples (this 5,000 years) and North American wood samples (this 10,000 years). In this presentation, I will be talking about the plan of the ^{14}C content measurement for the research about the past solar periodic activity and the severe SPE occurrence. Add to this, I will be introducing an outlook of a ^{10}Be content measurement which will show us a history of solar activity for a prolonged period.

Keywords: solar activity, cosmogenic nuclide

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Space plasma acceleration and geospace phenomena due to the energy/sphere couplings elucidated by in-situ observations

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The terrestrial ionosphere and magnetosphere in the polar regions are directly coupled each other through the field-aligned plasma particle transport and the plasma wave propagation basically along the geomagnetic field lines. The field-aligned currents are also carried mainly by the thermal and energetic electrons originating from the ionosphere and the magnetosphere, corresponding to the downward and upward current directions, respectively. The plasma motions widely drived in the magnetized space produce the electric fields due to the magnetohydro dynamics. This global electric field distribution by the plasma convection/circulation is regarded as sources of the plasma acceleration and the other types of the space plasma activities in the vicinity of the Earth. For instance, these properties of the space plasmas in the Geospace are the direct causes of the auroral activities, which means that the space plasma dynamics significantly affect the upper neutral atmosphere and hence stimulate the heating and the disturbances. These coupling processes could sometimes influence the upper atmospheric environment in the mid-latitude regions. It has also been revealed that the ionospheric plasmas are important for the magnetospheric dynamics in the Geospace through the upflowing mechanisms and the escape processes of the accelerated ionospheric plasmas at high latitudes and their density contributions, for instance, to the plasmasphere and the ring current region in the inner magnetosphere. The ionospheric plasmas are considered to be one of the most crucial elements controlling the magnetospheric plasma activities. In addition to the projection and/or propagation of the electromagnetic effects mentioned above, it should be noted that the plasma transport processes among the various regions in the Geospace including the ionosphere and the magnetosphere are fundamental for the space plasma dynamics, and these processes are called the sphere couplings in the Geospace. On the other hand, it is the wave-particle interaction in the space plasma to dominate the energy transfer among the different types of plasma population distributing almost isolatedly in several energy ranges because these plasmas in the topside ionosphere and the magnetosphere are essentially collision-free. In order to address these plasma dynamics in terms of the wave-particle interaction and the energy coupling, in-situ observations based on spacecraft explorations are playing the most fundamental role for the space plasma physics and the solar-terrestrial physics. While a number of the satellite/spacecraft mission have been carried out by the Japanese community and the overseas research agencies, we should recognize that it is not prevailing to cover the wide energy/frequency ranges of the plasma particles and waves and quantitatively investigate the energy transfer between the particles and the waves by using direct measurement techniques realizing high time resolution.

In this presentation, we introduce the previous and current space exploration missions performed mainly by our Japanese community, and also discuss the significance and the future perspectives of the in-situ observations which would bring us with more direct physical clues for the space plasma dynamics and the Geospace environment.

Keywords: space plasma, particle acceleration, Geospace, in-situ observation, space exploration mission, coupling process

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Aircraft observation on mesoscale and microphysical processes in a mesoscale convective system and typhoon

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Aircraft observations can provide high temporal and spatial information along the flight path, thus they are one of useful and important tools for understanding earth sciences as well as ground-based and satellite observations. The Meteorological Society of Japan proposed a research project entitled ”Promotion of Scientific Research on Atmosphere and Climate System Using Aircraft” as a candidate for Master Plan of Large Research Project announced by the Japan Council of Science. Under the project, we make a plan to conduct observations using an aircraft on the circulation and budget of the greenhouse gases, chemical processes of various species in the troposphere, interactions between aerosols and cloud particles, and cloud microphysical processes. Aircraft observations for three-dimensional wind, temperature, humidity, and microphysical properties in and around mesoscale convective systems (MCSs) and typhoons are critically useful for better understanding on the mesoscale and microphysical processes of the phenomena. These results obtained by aircrafts as well as the data assimilation technique are expected to improve the accuracy of numerical weather prediction for extreme phenomena.

However, few aircraft observations focused on mesoscale and microphysical processes are conducted by Japanese researchers. We have less experiences on the aircraft observations on the field. We also have less instruments loaded on a aircraft, thus we need to construct the instruments. For example, no research organization in Japan has a multi-channel dropsonde observation system now. It should be needed for the high spatial continuous observation on the atmospheric environment around MCSs and typhoons. Simultaneous observations of atmospheric and oceanic profiles using a dropsonde and airborne expendable bathythermograph (AXBT) or airborne expendable conductivity, temperature, and depth probe (AXCTD) enable us to explore the interaction between a typhoon and sub-surface layer of the ocean. A videosonde system dropping from an aircraft should be a useful tool to observe microphysical properties in the convective region where an aircraft cannot enter by strong turbulence. Microphysical properties obtained in MCSs and typhoons are useful information to evaluate satellite observations and numerical simulations. In comparison with the observation results on aerosol properties, it is possible to explore the interaction between giant cloud condensation nuclei (GCCN) such as sea salt, the warm rain process, and organization and heating profile in a MCS. Remote sensing instruments such as lidar and polarimetric radar loaded on an aircraft should be developed. Aircraft observations using these instruments around forming and rapidly developing typhoons give us new insight on the phenomena. Also, we have to acquire know-how to operate aircraft observations such as the submission and acceptance of the flight plans, maintenance of instruments and logistics support.

Keywords: Aircraft observations, typhoons, mesoscale convective systems, microphysical processes, observational instruments

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Observations of dynamical and chemical variations of mesosphere, thermosphere, and ionosphere at the EISCAT Tromsoe site

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We will introduce our activities at Tromsoe (69.6N, 19.2E) in northern Scandinavia, and will talk about our future plan as well. The EISCAT radar system has been operated over 30 years, and Japan joined the EISCAT scientific association in 1996. Since then, Japanese scientists have used the EISCAT radars to study the polar ionosphere and thermosphere. To facilitate the activities as well as extend height and horizontal coverage of observations which lead us to study the atmospheric vertical coupling and the ionospheric currents/aurora dynamics in more detail, we have installed and operated several instruments at the EISCAT Tromsoe site. A sodium LIDAR, an MF radar, a meteor radar, an FPI, a photometer, all-sky auroral imagers, an all-sky airglow imager, satellite beacon receivers are under operation. By utilizing these instruments, we study several topics occurring in the polar mesosphere/thermosphere/ionosphere. In the near future, a millimeter wave receiver for measuring minor constituent in the stratosphere/mesosphere/lower thermosphere will be installed. Furthermore, the new EISCAT radar, so-called EISCAT_3D, is planed.

Keywords: Thermosphere, Ionosphere, Mesosphere, EISCAT radar, sodium LIDAR, polar region

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Development of superconducting device for millimeter-wave atmospheric radiometer 2

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Minor atmospheric molecules radiate millimeter and sub-millimeter wave by rotation transition. Therefore, Division of Atmospheric Environment in Solar-Terrestrial Environment Laboratory, Nagoya University is operating the millimeter wave atmospheric radiometers, and monitoring long-term time variation and altitude distribution of minor atmospheric molecules in the middle atmosphere. Our monitoring molecules are O_3(208.7GHz, 235.7GHz), NO(250.9GHz), and ClO(204.3GHz). We have observation sites in Rikubetsu town in Hokkaido, Atacama highland in Chile, Rio gallegos in Argentina, and Syowa station in Antarctica. Moreover, we will set a new radiometer in Tromso, Norway in this year.

The capabilities of the millimeter wave radiometer are almost determined superconductivity device installed in radiometer. Therefore, we are developing a new superconductivity SIS (Superconductor-Insulator-Superconductor) device in millimeter and sub-millimeter wavelength for our radiometers under the collaboration with Advanced Technology Center, National Astronomical Observatory of Japan. Especially, we are developing new device in 200 GHz band (wavelength ˜1.5 mm) for the radiometers installed in Atacama and Tromso. Current devices can observe only limited molecules at one time, because the frequency range is very narrow. Therefore, we have started development of high sensitive device in wide bandwidth to observe a lot of molecules simultaneously. Specifically, we plan to make new device of which receiver noise temperature is less than 30 K from 190 to 260 GHz.

So far, we designed the transmission line for impedance matching between the feed point and SIS junction, which contains MSL (Micro-Strip Line) and CPW (Coplanar Wave Guide), based on the analysis of electromagnetic simulator and electrical circuit simulator. Specifically, we designed new device in 200 GHz band which was based on previously developed in 100 GHz band (Inoue 2011), and was fixed the structure between junction to junction which cannot be considered previously. As the result of simulation based on Tucker's quantum theory, we have successfully designed the new device of which receiver noise temperature is less than 30 K from 170 to 270 GHz. Now we have finished making the devices and we are measuring properties in laboratory. Therefore, we plan to measure other devices and the results feedback to next device design.

In this presentation, we describe the design, result of measurement properties in laboratory, and prospect for mounting millimeter wave atmospheric radiometer.

Keywords: middle atmosphere, minor molecules, millimeter wave, radiometer, superconducting device, SIS mixer

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Development of seamless science using the SuperDARN network

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Super Dual Auroral Radar Network (SuperDARN) is the network of HF radars operated under the international collaboration of 12 countries. As of Feb 2015 there are 33 SuperDARN radars deployed in the high and mid latutude regions of both hemispheres. Nagoya University has been operating SuperDARN Hokkaido Pair of (HOP) radars since 2006 and 2014. Using the radars it is possible to explore the seamless science ranging from the sun, magnetosphere, ionosphere and the ionosphere, down to the earth's surface. Future perspectives of the seamless science using the SuperDARN network will be discussed.

Keywords: SuperDARN, seamless science, sun, the earth's surface, magnetosphere, ionosphere

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Seamless study of ocean ecosystem, atmosphere and land with observation from space

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Phytoplankton as a major primary producer in the ocean is not only important to control the ocean ecosystem and fish production but also to control material cycles such as carbon. Visible light radiated from sun passes through atmosphere and transports to ocean, and it is absorbed and scattered by phytoplankton and other materials. Then, part of the radiation goes back to space after radiation from the sea surface. It is now becoming possible to measure the wavelength dependency of the light (ocean color) to estimate quantity and quality of phytoplankton and other materials in the water. From the ocean color remote sensing data, variation of phytoplankton amount in the East China Sea is clearly depended on the variation of the Changjiang river discharge, and the high phytoplankton water reached to near Japan when the discharge was high. This is because Changjiang river water is influenced by human activity, and contains large amount of nutrients. On the other hand, phytoplankton in the Yellow Sea is increasing, and phytoplankton composition is also changing. Very high phytoplankton water is called red tide and influenced to human activity, such as aquaculture, and it is also detected by satellite. GCOM-C will be launched in 2017 and observe almost everyday with 250m resolution, and it is expected to be used to reduce the damage of the red tide. On the other hand, Korean geostationally ocean color sensor, GOCI, is possible to observe every one hour during the daytime, and rapid change of phytoplankton after passing the typhoon was detected. Furthermore, nutrient can be transported though atmosphere and phytoplankton amount can be increased; however, improvement of accuracy of phytoplankton concentration is necessary because of the error caused by the aerosol. It is expected to study seamlessly though ocean ecosystem, atmosphere and land with the ocean color remote sensing from space.

Keywords: ocean color remote sensing, phytoplankton, river, aerosol, typhoon, ocean ecosystem

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SCOSTEP's international program (2014-2018): Variability of the Sun and Its Terrestrial Impact (VarSITI)

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During the last solar minimum, solar activity was extremely low for an extended period, and the present maximum of sunspot cycle 24 is the lowest in the last 100 years. It is not clear what long-term solar activity variations we can expect in the future: whether this is just the end of the recent decades of high solar activity, or whether the Sun is entering a Maunder-type minimum. Moreover, it is not clear to what extend our present understanding of how the Sun influences the geospace - which is based on instrumental observations taken during only the period of high solar activity in the second part of the 20th century - will hold during periods of more moderate to low solar activity that may follow. And it is still more unclear how all this would affect global climate change, or how important becomes the penetration of various inputs from the Earth's lower atmosphere to the ionosphere and plasmasphere. In 2014-2018 the Scientific Committee On Solar-TErrestrial Physics (SCOSTEP) operates the scientific program "Variability of the Sun and Its Terrestrial Impact" (VarSITI) which will focus on the recent and expected future solar activity and its consequences for the Earth, for various time scales from the order of thousands years to milliseconds, and for various locations and their connections from the solar interior to the Earth's atmosphere. In order to elucidate these various Sun-Earth connections, we encourage much closer communications between solar scientists (solar interior, atmosphere, and heliosphere) and geospace scientists (magnetosphere, ionosphere, and atmosphere). Campaign observations/data analysis for particular intervals, VarSITI web pages (http://www.varsiti.org/), mailing lists, and newsletters, are developed for this purpose. Four scientific projects are carried out under the VarSITI program: (1) Solar Evolution and Extrema (SEE), (2) International Study of Earth-Affecting Solar Transients (ISEST/MiniMax24), (3) Specification and Prediction of the Coupled Inner-Magnetospheric Environment (SPeCIMEN), and (4) Role Of the Sun and the Middle atmosphere/thermosphere/ionosphere In Climate (ROSMIC). These four projects will be carried out in collaboration with relevant satellite and ground-based missions as well as modeling efforts to facilitate the implementation of the projects. We will also discuss the collaboration with other on-going international projects like the UN-based space weather activities, particularly for promoting VarSITI-related science in developing countries, and ICSU World Data System (ICSU-WDS).

Keywords: solar variability, climate change, VarSITI, international program, SCOSTEP

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Space Quantum Red Shift Hypothesis and New Theory of Non-Expansion Universe

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Farther By farther from the Earth, the red-shift of the star is observed as a large value, Hubble has been reported. This expanding universe hypothesis that the red-shift was interpreted as a Doppler effect (Big Bang) has become a accepted notion. In the Big Bang hypothesis, total mass had been exploded at the point, The more distant light source moves away from Earth, has been explained the observed results (red-shift) in the Doppler effect. Isotropic background radiation of the universe had been regarded as proof of the 16 billion years ago the Big Bang of relic.However, it is not possible explain the basis of causing red-shift in the center of the earth, who began say it is unknown, has become dogma interpretation space.The expansion of space that can not be demonstrated on the planet,it is in a strange hypothesis that can be observed in the light from the distant universe.

In Mr. M.Rowan Robinson unknown encyclopedia (1) p95, ”background radiation of energy density (distribution Profile).Is, it is that similar to the energy distribution that was averaged gathered the light of the stars come from many galaxy. Have not found the that how to deformation of these star light in the form of black body radiation of 2.7 degree K. It have pointed out the fact that the profile of background radiation is similar to the wavelength distribution of the sun (Profile). It is assumed that the universe is closed and the law of the conservation of energy has been satisfied strictly in this hypothesis, If you can explain the peak wavelength position of the sun other than Doppler effect, if there is a hypothesis that can explain the red-shift of the center of the earth, space does not need to be inflated.Light advanced beyond the universe I was assumed to be coming from the opposite direction toward the Earth. Typical star of light energy is gradually diluted to space depending on the distance obtained by adding the cosmic radius passing through,Traveling wave spreading, which is also conserved in the wavelength range that does not appear quantum effect, the energy is observed to be shifted to be diluted longer wavelength side. The deviation of the light energy dilution and wavelength, I was interpreted as Space quantum red-shift effect. In space quantum red-shift effect centered on the observation point of the Earth, I explained the law of Hubble and Isotropic background radiation at the same time. Total mass is not also necessary to expansion difficulties and space to focus at one point, it becomes possible to honestly understand the red-shift observed in the center of the earth in a stationary universe.

If the universe is closed, the inertial mass is a reaction of all the universe (attraction), and it is also the reason why the universe is not collapse. Steady-state theory of the universe was completed here.

Keywords: Space Quantum Red Shift Hypothesis, New Theory of Non-Expansion Universe, Hubble’s Law, Runbart’ Law, Explain of 3degree K Back graund Radiation, conservation of energy