# JAXA TODAY

Japan Aerospace Exploration Agency
January 2011 / No. 03

Special Features

## Professor Jun'ichiro Kawaguchi:

### Reflecting on the Hayabusa mission and the future of space exploration

## Particles brought back from Asteroid Itokawa:

### What methods did researchers use to discover particles inside Hayabusa's sample-return capsule?

JAXA
Japan Aerospace Exploration Agency

Contents



Midori Nishiura, advisor to JAXA on public affairs, interviewed Professor Jun'ichiro Kawaguchi on such topics as the development of Japan's space probes and the future of space exploration.



What methods did researchers use to discover the particles brought back from Asteroid Itokawa inside Hayabusa's sample-return capsule? Nonfiction writer Kazuma Yamane received firsthand insights on this painstaking process from Professor Akio Fujimura of the Institute of Space and Astronautical Science (ISAS).



We recap the main tasks and significance of JAXA Astronaut Soichi Noguchi's long-endurance mission on the International Space Station (ISS).



Four principal investigators introduce their respective scientific experiments currently being conducted on JEM Kibo, one of the ISS' modules.



A roundup of JAXA's recent activities



# Welcome to JAXA TODAY

The Japan Aerospace Exploration Agency (JAXA) works to realize its vision of contributing to a safe and prosperous society through the pursuit of research and development in the aerospace field to deepen humankind's understanding of the universe. JAXA's activities cover a broad spectrum of the space and aeronautical fields, including satellite development and operation, astronomical observation, planetary exploration, participation in the International Space Station (ISS) project, and the development of new rockets and next-generation aeronautical technology.

With the aim of disseminating information about JAXA's activities and recent news relating to Japan's space development programs to as wide an audience as possible, we launched JAXA TODAY in January 2010. Marking the first anniversary of the launch of JAXA TODAY, in this, the third issue, we feature an interview with Professor Jun'ichiro Kawaguchi, who led the Hayabusa project, and also provide a close-up look at how the particles brought back from Asteroid Itokawa were discovered inside Hayabusa's sample-return capsule. In addition, this issue includes a report on the activities of JAXA Astronaut Soichi Noguchi during his long-endurance mission on the ISS as well as a selection of articles on other topics that we hope you will enjoy.

## A *Miuta* (*Waka*) Poem by Her Majesty the Empress

The asteroid probe Hayabusa succeeded in collecting a sample of material on Asteroid Itokawa and returned to earth on June 13, 2010. In this poem Her Majesty describes how, after completing its long journey in space, Hayabusa broke up and incinerated in a large fireball as it reentered the earth's atmosphere.

「はやぶさ」

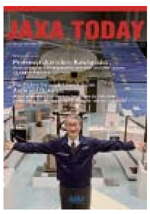
その帰路に　己れを焼きし　「はやぶさ」の
光輝（かがや）かに　明かるかりしと

Hayabusa

Our Hayabusa
Incinerating itself
On its return
A blazing ball of fire
Luminous and brilliant.

Source: The Imperial Household Agency

## Cover Story




Professor Jun'ichiro Kawaguchi is the manager of the Hayabusa project, which achieved a major breakthrough by becoming the first space mission in history to return to Earth a sample of material from a celestial body other than the Moon or a comet. For this photograph, taken on November 15, 2010, Professor Kawaguchi posed in front of a full-scale model of Hayabusa.

*Photo by Hiro Arakawa*

Interview with the professor

# Jun'ichiro Kawaguchi

Interviewed by

**Midori Nishiura,**

Executive Advisor for JAXA Public Affairs & International Relations

## Hayabusa project manager Professor Jun'ichiro Kawaguchi discusses the Hayabusa and IKAROS missions and also provides his views on the importance of space exploration. He emphasizes that all his efforts are focused on achieving progress for the benefit of humankind.

After a space voyage spanning more than seven years and six billion kilometers, the asteroid explorer Hayabusa completed its mission with a triumphant return to Earth on June 13, 2010. In this interview, we discussed a range of issues with Hayabusa project leader Professor Kawaguchi, including:

- The numerous challenges the Hayabusa mission overcame on the way to its historic accomplishments;
- The ongoing steady progress of IKAROS, the Small Solar Power Sail Demonstrator; and
- JAXA's approach to space exploration.

**Editor's note regarding the timing of this interview**

On November 16, 2010, the day after we conducted this interview with Professor Kawaguchi, JAXA announced that its analysis of particles collected from inside the return capsule's sampler container had identified the particles' origin as Asteroid Itokawa. This announcement—which vindicated Professor Kawaguchi's strong conviction that "there is almost certainly a sample in there"—disclosed that 1,500 asteroid particles had been found inside the container.

*Photo by Hiro Arakawa*


*Photo by Hiro Arakawa*

**Hayabusa: Passing on cutting-edge technology to "Hayabusa-2"**

***Nishiura: Congratulations on the successful return of Hayabusa. This spacecraft has really captured the imagination and hearts of the Japanese people and established its place in popular culture. Hayabusa books and DVDs are at the top of the bestseller lists and it was even one of the biggest topics on the micro-blogging site Twitter.***

**Kawaguchi:** Thank you very much. Hayabusa's success is truly the result of the fortitude and perseverance of the entire project team. I would like to take this opportunity to express my heartfelt gratitude to everyone who has supported both Hayabusa and JAXA.

***Nishiura: When Hayabusa returned on June 13, 2010, the feelings of elation—that your "baby" had finally come home—must have been tempered by the harsh reality of atmospheric reentry.***

**Kawaguchi:** When the spacecraft made its reentry, I didn't stay in the control room. I went back to my office to watch it alone. I wasn't confident that I could maintain my composure while watching the monitor in front of all my staff.

***Nishiura: Please tell us how you felt the following day, June 14, when the return capsule was recovered.***

**Kawaguchi:** More than jubilation, my foremost emotion was one of astonishment.


> "The commitment of the team was extraordinary. They were united in working toward the goal of getting Hayabusa successfully back to Earth, no matter what."
>
> *—Jun'ichiro Kawaguchi*

The main reason being that the capsule had landed a mere 500m from the planned drop zone. We were also very lucky in that we spotted the capsule very quickly from the Royal Australian Air Force helicopter. Originally, we thought the recovery might take about two weeks.

***Nishiura: Hayabusa provided the opportunity for a practical demonstration of a wide array of new technologies. Can you briefly outline the key new technologies you used?***

**Kawaguchi:** The Hayabusa mission was used to verify the following major new technologies: (1) ion engines that provided electric-powered propulsion through the ionization of xenon gas; (2) an autonomous optical navigation system that enabled Hayabusa to approach and touch down on Asteroid Itokawa; (3) sample collection on Itokawa; (4) an Earth swing-by using Earth gravity assist; and (5) the recovery of a sample-return capsule made from heat-resistant materials. These technologies will be essential for future missions that aim to gather and return samples from other bodies in the Solar System.

***Nishiura: Hayabusa faced many crises during its mission, but each time it managed to pull through. The mission contained so many dramatic twists and turns that it reads like the plot for a blockbuster movie! Are there any particular episodes that stand out for you personally?***

**Kawaguchi:** In December 2005, shortly after Hayabusa made

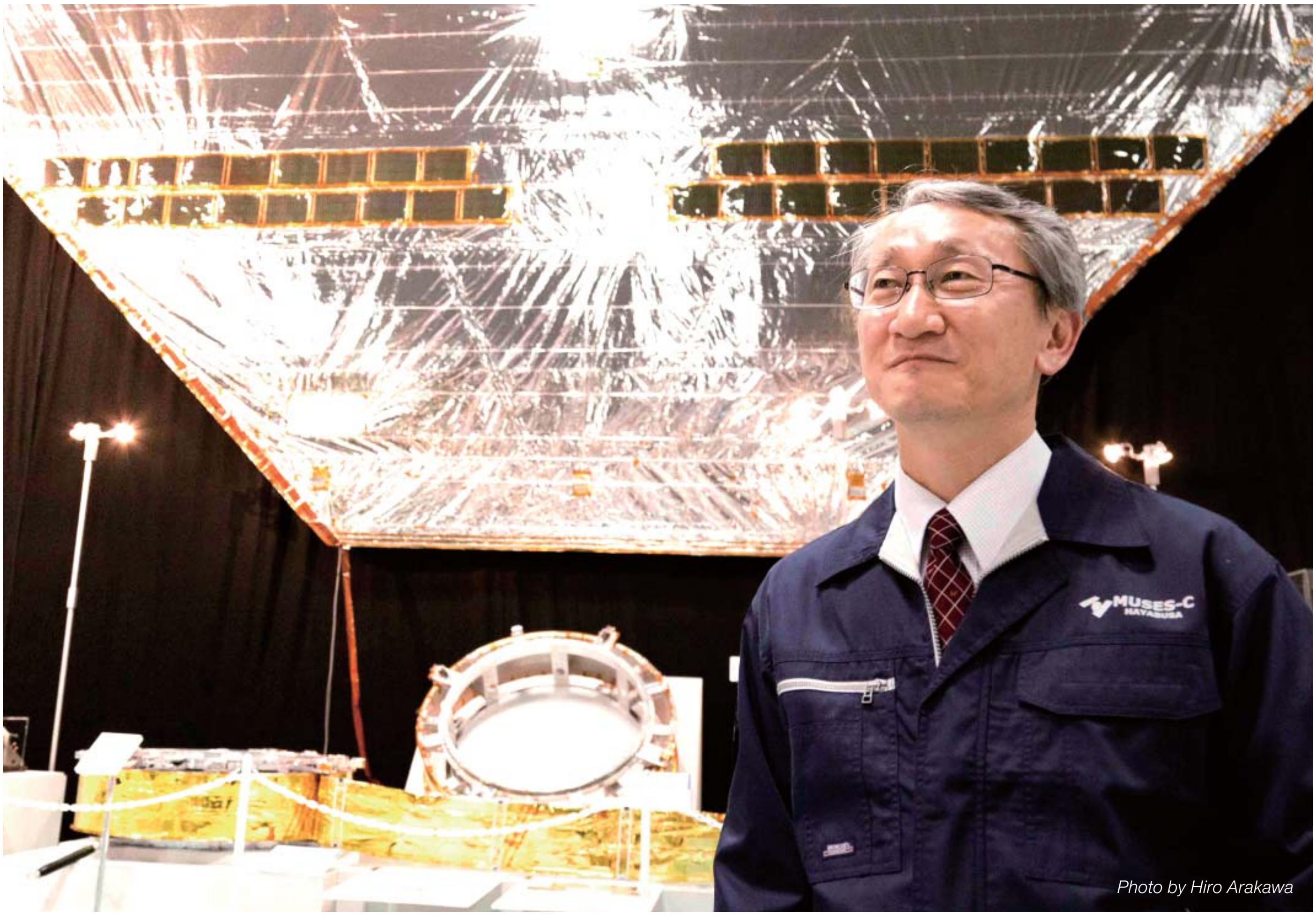



Photo by Hiro Arakawa

*Professor Kawaguchi with a model of IKAROS at a recent exhibition*

two touchdowns on Itokawa, we lost all communication with the spacecraft. At that point, I thought, "Is this the end?" The radio signals we were receiving in the Control Room got weaker and weaker, and we could tell that it was slipping further away from us. Itokawa is about three billion kilometers from Earth, so it takes around 20 minutes for the radio signals to reach us. Consequently, by the time we had received the radio signals, Hayabusa was already missing. It was an awful feeling. The other particularly memorable episode was in November 2009, when all four ion engines shut down. We successfully restarted two engines by using a "cross operation" workaround whereby we paired together still-operable neutralizers and thrusters from separate engines. The main engineer we were working with at NEC Corporation—which developed the ion engines—suggested we try running a bypass circuit to effect cross operation. It really was an ingenious solution.

***Nishiura: For the Hayabusa project, you cooperated with both NASA and the Australian government. What did this involve?***

**Kawaguchi:** We received full cooperation from NASA, including the operation of a large antenna tracking network. NASA has very large manpower capabilities, which have been incredibly reassuring for us. In addition, many Australian government personnel readily lent their support. When we approached them and asked them to provide a place where the sample-return capsule could be recovered, they agreed to our request saying, "This is for the benefit of humankind." Rather than simply pursuing their own national interests, those people overseas who gave their cooperation always considered how they could contribute to progress for all humankind. This generosity of spirit was very inspiring.

***Nishiura: How would you describe the atmosphere in the team that you built for the Hayabusa project?***

**Kawaguchi:** The commitment of the team was extraordinary. They were united in working toward the goal of getting Hayabusa successfully back to Earth, no matter what. And that even meant putting their own personal circumstances on the back burner, in many cases. I am confident that they could outperform any other project team.






*Professor Kawaguchi in his office and with members of his team*

***Nishiura: In light of Hayabusa's accomplishments, it must place even greater expectations on its successor mission, Hayabusa-2?***

**Kawaguchi:** Hayabusa was a demonstration project for a wide range of technologies necessary in the collection and return to Earth of samples from an asteroid. In actual fact, our full-scale program for an asteroid sample-return mission will start in earnest from now. The Hayabusa-2 mission we are planning at present will explore an asteroid called 1999 JU3. This is a C-type (carbonaceous) asteroid that is thought to contain organic matter and hydrated minerals—prerequisites for the formation of life. Our current plan envisages a launch in 2014 and a return to Earth in 2020, and includes as one of its goals the collection of a sub-surface sample from the asteroid, something that Hayabusa was unable to achieve. We would be honored to receive again the enthusiastic support of people in Japan and overseas.

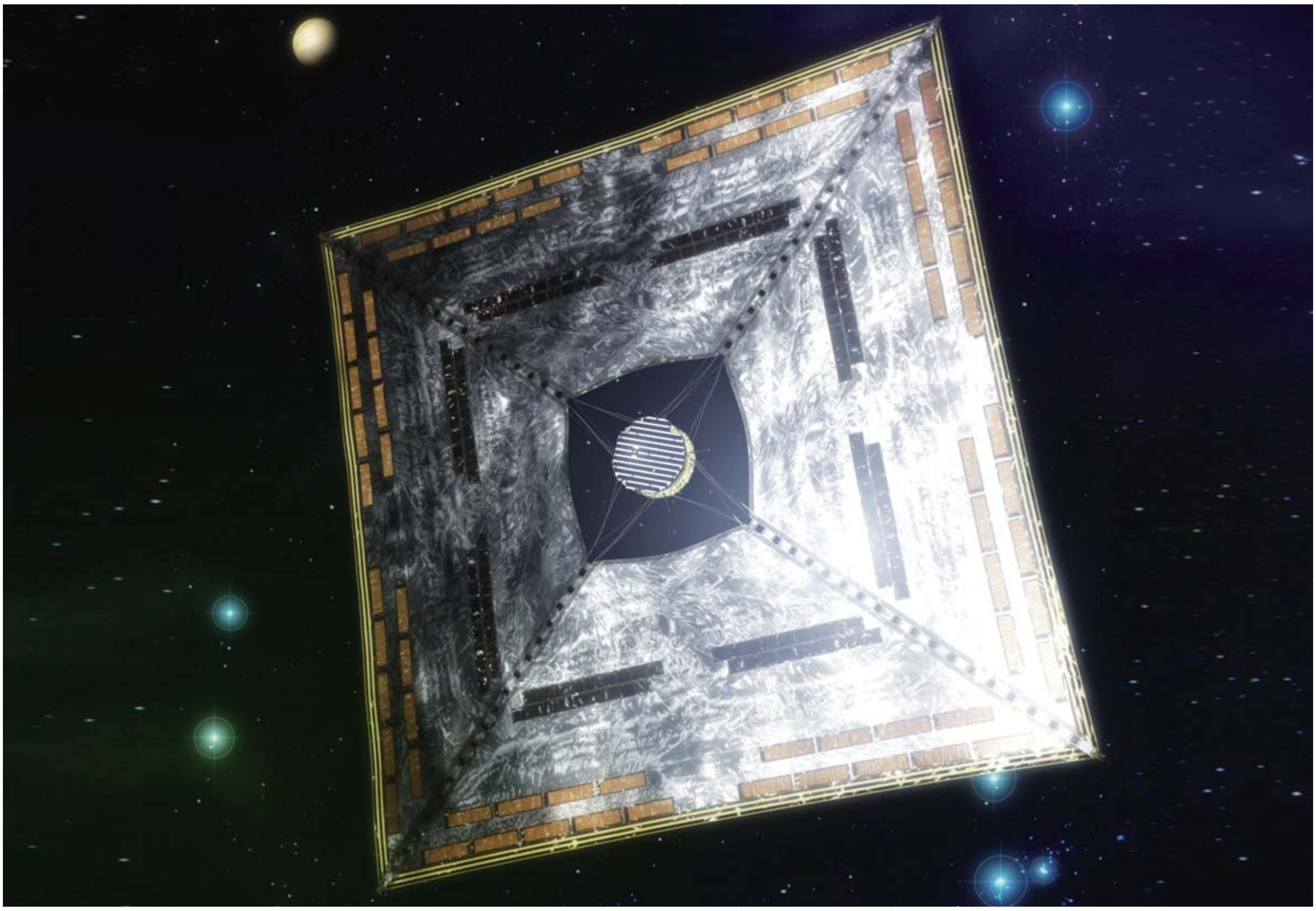
## IKAROS: Japan's original solar power sail

***Nishiura: Following on from the success of Hayabusa, there has been a stream of good news about the IKAROS mission and almost all of the project's goals being achieved to plan. What are the key features of the IKAROS project?***

**Kawaguchi:** IKAROS—launched in May 2010—is a demonstration spacecraft for solar sail technology, which uses the photons in sunlight as its source of propulsion, as well as thin-film solar cells that are embedded into the sail membrane. This solar power sail is an original Japanese concept, and the planned objectives of the mission were: (1) deployment of the sail; (2) generation of electricity using the solar cells; (3) acceleration and deceleration of the spacecraft using the solar sail; and (4) orbit control using the solar sail. We have already achieved each of these objectives, which were all world firsts.

***Nishiura: What kind of project team is conducting the IKAROS mission?***

**Kawaguchi:** The IKAROS team mainly comprises young scientists and engineers. The project manager is in his mid-thirties, and many of the other members are even younger. In fact, the majority of the IKAROS team joined JAXA after the May 2003 launch of Hayabusa.



*An artist's rendition of IKAROS as it cruises beyond Venus into deep space after achieving full mission success*

*Photo by Hiro Arakawa*

Looking to the future, one of the additional goals of the IKAROS project is to develop the skills and talents of our younger staff members by providing them with a diverse range of practical experience.

***Nishiura: At present, IKAROS is on course cruising toward Venus. What is planned for the spacecraft from here on?***

**Kawaguchi:** The core objective of the IKAROS mission is not the exploration of Venus, but to carry out various experiments necessary for interplanetary travel. From now, IKAROS will pass close to Venus and begin a continuous orbit around the sun.

***Nishiura: Will there be a successor to IKAROS analogous to the Hayabusa-2 project?***

**Kawaguchi:** In the second half of the current decade, under the Jupiter and Trojan Asteroids Exploration Program we plan to send an interplanetary probe using a solar power sail to explore the area around Jupiter. However, Jupiter is extremely distant from the sun, so the amount of solar rays reaching Jupiter is only one twenty-fifth the amount reaching Earth. For this reason, on the new spacecraft we plan to deploy a solar power sail that is much larger than the one being used on IKAROS.

### Space exploration: Aiming for celestial bodies never before visited by other missions

***Nishiura: As was the case with the Hayabusa project, it seems that international collaboration is common in the field of space exploration. What are the reasons behind this?***

> "The IKAROS project is to develop the skills and talents of our younger staff members by providing them with a diverse range of practical experience."
>
> —Jun'ichiro Kawaguchi

> "In light of Hayabusa's accomplishments, it must place even greater expectations on its successor mission, Hayabusa-2."
>
> —*Midori Nishiura*

**Kawaguchi:** If we consider the operational and cost aspects of space exploration projects, it is only through international collaboration that we can begin to achieve significant results. For example, training programs for JAXA astronauts are carried out at the NASA Johnson Space Center (JSC), and the ISS is operated jointly by 15 countries, including Japan. In undertaking space exploration for the benefit of humankind, it is only natural that many countries should choose to cooperate in striving for this greater good.

***Nishiura: How do you think Japan's space exploration technology rates on a global basis?***

**Kawaguchi:** In terms of spacecraft development and operation, I have no doubt that Japan's capabilities right now are world class. In the past, the United States and the former Soviet Union mainly focused on exploring large celestial bodies, such as the Moon and Mars. In contrast, I think it is very significant that Japan has devoted much effort to exploring smaller celestial bodies—such as Itokawa—that no one had yet been to or seen up close.

***Nishiura: Please tell us about your ambitions for future projects.***

**Kawaguchi:** To expand our pool of human resources for various project teams, we need to develop younger personnel. I want young people to forge ahead and keep taking on new challenges without limiting their own capabilities. There can be no innovation without risk. While following my personal motto, "Do what others don't do," I, too, look forward to competing with these young people.

*Midori Nishiura,*
*Executive Advisor for JAXA Public Affairs & International Relations*

*Photo by Hiro Arakawa*

## Profiles


*Photo by Hiro Arakawa*

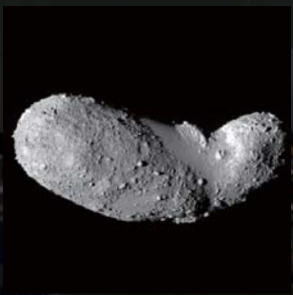
### Dr. Jun'ichiro Kawaguchi

Project Manager,
Program Director, Lunar and Planetary Exploration Program Group, JAXA Space Exploration Center (JSPEC)
Professor, Department of Space Systems and Astronautics, Institute of Space and Astronautical Science (ISAS), JAXA

Jun'ichiro Kawaguchi was born in Aomori, Japan, in 1955. He completed the doctoral program at the Department of Aeronautics and Astronautics, Graduate School of Engineering, University of Tokyo, in 1983. In the same year, he joined the Systems Research Division at ISAS as an assistant professor. In 2000 he was made a full professor. Concurrently, Professor Kawaguchi is the program director of the JAXA Space Exploration Center (JSPEC). His areas of specialty include control systems and astrodynamics (applied flight dynamics), and his personal motto is "Do what others don't do." He is the project manager of the asteroid explorer Hayabusa mission.

### Midori Nishiura

Midori Nishiura, an opinion leader, is president of consulting firm Amadeus Inc., JAXA's Executive Advisor for Public Affairs & International Relations, and Visiting Professor of International Relations & Communications at Yamaguchi University. Among many other important roles, Ms. Nishiura has served on the Advisory Board of various major companies and also sits on committees organized by government ministries and agencies. Author of many books as well as articles in leading publications, Ms. Nishiura, having conducted her own interview programs on television, is often called upon to commentate on the news.



# How many particles from Itokawa was Hayabusa able to capture?

**Nonfiction writer Kazuma Yamane speaks with Professor Akio Fujimura**

*Hayabusa's reentry fireball photographed from Woomera, South Australia*

# "Origin of particles identified as Asteroid Itokawa"

The announcement on November 16, 2010, made headlines in Japan and around the world. The origin of the large number of particles recovered from inside the sample-return capsule brought back to Earth by Hayabusa was identified as Asteroid Itokawa.

Hayabusa project manager Professor Jun'ichiro Kawaguchi had set success criteria for the mission covering each stage, with a maximum of 500 points if all major milestones were achieved. Points earned under the success criteria—awarded for eight milestones from the commencement of operation of the spacecraft's ion engines to obtaining a sample for analysis—had been stalled on 400 points since the return capsule was successfully recovered on June 13, 2010. However, with this announcement the mission has achieved the maximum of 500 points. After a marathon journey, Hayabusa has taken full honors at the finishing line.

What the field emission scanning electron microscope (FE-SEM) had identified were approximately 1,500 minute particles, each measuring less than 0.01 millimeter. On November 29, 2010, there was a further announcement that several hundred more particles, which could be observed through an optical microscope, had also been identified, and these larger particles had a maximum size of 0.1 millimeter. This remarkable accomplishment is the first time that humankind has obtained a sample from a celestial body beyond the Moon, and there are high expectations that the sample will unlock a treasure trove of groundbreaking discoveries as scientists from Japan and overseas analyze the sample to unravel such mysteries as the origin of the Solar System and the beginnings of life.

The Hayabusa sample-return capsule, recovered from the Woomera Prohibited Area (WPA) in Australia's outback on June 14, 2010, was taken to the planetary sample curation facility at the ISAS Sagamihara Campus in Kanagawa Prefecture in the early hours of June 18, 2010. Subsequently, the sample was removed from the capsule and the initial analysis and classification database entry was carried out. The curation facility comprises a clean room facility on par with those used at state-of-the-art semiconductor fabrication plants and will be utilized in the distribution of portions of the sample to researchers from Japan and abroad. The sample—and information relating to it—is being managed very stringently, hence details on how the particles were discovered has remained under wraps. To shed further light on this process, we spoke to Professor Akio Fujimura (ISAS Planetary Science Group), manager of the curation facility, who provided background explanations on how the capsule contents were being recovered.

***Dr. Akio Fujimura***

*Professor, Department of Planetary Science, Institute of Space and Astronautical Science (ISAS)*
*Professor, Lunar and Planetary Exploration Program Group, JAXA Space Exploration Center (JSPEC)*

## Special spatula used to remove particles from the sample catcher chamber

"This is the sample catcher chamber that contained particles from Itokawa. The particles were scraped from the interior of the chamber using a specially designed Teflon spatula and then observed using an FE-SEM." (Professor Fujimura)

After putting on surgical gloves, Professor Fujimura picked up and showed me a replica of the sample catcher. Looking at the overall structure of Hayabusa's sample-capsule, one may use the analogy of a truck and its payload. In this case, the heat shield—scorched from its fiery reentry—would be the truck and the capsule would be the truck's rear deck. The particles collected from Itokawa are stored in the sample catcher chamber, which is inside a larger sample container—analogous to the shipping container carried on the deck of the truck.

Since the main mission of the Hayabusa project was said to be the collection and return of rocky fragments from Itokawa, I had assumed that the chamber to hold the sample would be quite large. However, the cylindrical sample catcher carefully handled by Professor Fujimura using surgical gloves was only about five centimeters in diameter and six centimeters tall. It was surprisingly small and light—maybe about the size of a whisky shot glass. But outward appearances can be deceptive—its structure was in fact highly complex.

On the side of the cylindrical sample catcher there is a central, round aperture. When Hayabusa touched down on Itokawa, this aperture was facing downward. Extending out from the aperture was the sampler horn, the end of which touched the surface of Itokawa. Some of the asteroid fragments propelled up into the horn entered the sample catcher through the aperture. On the inside of the aperture, there is a smaller cylinder that has a slit in it, and the sample was sent into the sample catcher's B chamber.

"We made the revolving part slippery by interfusing Teflon into the surface of the oxide layer-treated Duralumin (aluminum alloy)." (Professor Fujimura)

Before the second sample was taken, the small, slitted cylinder was rotated so that the second sample was sent into the sample catcher's A chamber on the opposite side. Chamber A is near to the catcher's lid while chamber B is near to the base. The capacity of each of the A and B chambers is probably similar to a small salt shaker. The modest size of the sample containers indicates how extremely small the estimated sample would be.

"Yes, we estimated that the sample would comprise grains up to the size of common sugar granules and would total 1–2 grams." (Professor Fujimura)

Although the sample—comprising more than 1,500 particles measuring under one hundredth of a millimeter and a further several dozen grains of up to one tenth of a millimeter—was slightly smaller than the envisaged amount, it is still a great accomplishment.

"Since the sample catcher body needed to be strong, we fabricated it from Duralumin and used stainless steel screws. However, the interior has a vapor-deposited coating of pure aluminum. The reason behind this was that even if there was some mingling of Earth-origin materials with the sample, we wanted to try and limit the quantity and types (elements) of such materials to the smallest numbers possible." (Professor Fujimura)

In the clean room within the curation facility, when the ISAS researchers first opened up the sample catcher, they couldn't see anything that looked like a sample at all. All they saw was the very shiny vapor-deposited aluminum coating.

"It was so clean, the research team were rather disappointed." (Professor Fujimura)

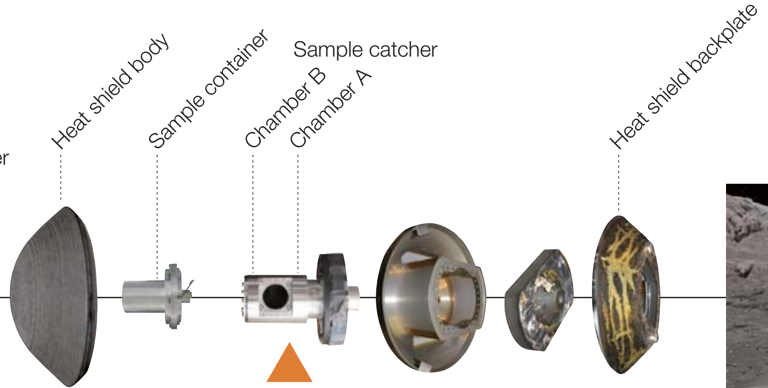
Despite this, the researchers assumed that there were tiny particles in there that could not be seen with the naked eye. To scrape such particles out of the chamber, the ISAS team commissioned an FE-SEM manufacturer (Hitachi, Ltd.) to produce a special Teflon spatula.

**Structure of the capsule that protected the Itokawa sample during its return journey**

**Jan. 18, 2007**
Closure of capsule lid

**Jun. 13, 2010**
Atmospheric reentry

**Jun. 20, 2010**
Opening of sample container




**Nov. 20, 2005**
1st touchdown (Chamber B)

**Nov. 26, 2005**
2nd touchdown (Chamber A)

Asteroid Itokawa


Hayabusa collected samples in chambers A and B of its sample catcher during its two touchdowns on Itokawa in November 2005. Subsequently, a leak of fuel from one of Hayabusa's chemical engines caused a malfunction and the loss of all communications with the spacecraft's controllers for several weeks. In late January 2006, partial communications were restored. Several months were then spent recharging Hayabusa's barely operational Li-ion battery. In January 2007, the capsule was successfully closed, latched, and sealed.

Since the head of the spatula is only about five millimeters wide, the end and side have an edge similar to a knife blade. By gently rubbing the spatula along the interior walls of the sample catcher chamber, the researchers hoped that particles invisible to the human eye would sink into and adhere to the Teflon. They then checked the head of the spatula using an FE-SEM. Through this process, the team was able to verify more than 1,500 particles.

However, along with the sample particles, the team also found approximately 1,800 aluminum particles intermingled. These particles had detached from the vapor-deposited aluminum coating used on the chamber's interior walls. This amount was very small and well within the range the team had anticipated. It was not surprising that it had taken quite a long time to observe and analyze each particle individually using the FE-SEM.

## Hopes that further particles will be found in the sample containers

On November 29, 2010, JAXA announced that it had found several hundred larger particles measuring up to 0.1 millimeter. It was reported that the grains had fallen out after tapping on the container, but this tapping was not by any means done on a whim. To examine the sample catcher's B chamber on the opposite side, whose lid was still closed, it was necessary to turn the sample catcher upside down.

"While placing an artificial quartz platter over the sample catcher's A chamber aperture, we lightly tapped the container while holding it upside down. When we restored the sample catcher to its upright position, we could see a faint cloudiness on the surface of the platter. When we checked with a microscope, we found that unexpectedly large grains had fallen out." (Professor Fujimura)

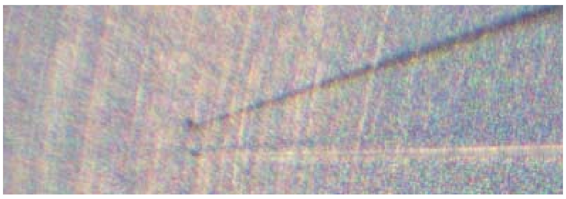
The researchers hope that an even larger amount of sample material will be recovered from the as-yet unopened sample-catcher B chamber. There is also the possibility that loose particles may be present in the capsule—those that never made it as far as the sample-catcher chamber. The process for finding such particles has yet to be carried out.

Particles recovered in the manner described above are sorted and classified by placing them on an artificial quartz glass slide measuring 26mm x 40mm, with a thickness of 1mm. On the surface of the glass slide is a laser-etched grid at 1.5-millimeter intervals with numbered coordinates assigned. At each grid intersection a tiny hollow has been carved, and each of the particles are individually placed in one of these hollows. The particles adhere to the glass slide surface through the force of static electricity, so there is no risk of them falling off. After this sorting and classification process has been completed, the particles will be distributed to the Initial Analysis Team comprising researchers from universities around Japan.

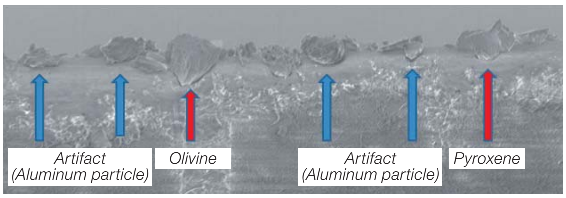
## Cheered on by NASA personnel

Professor Fujimura personally led the team that conducted the painstaking five-month process of examining each particle—invisible to the naked eye—one by one. The procedures were carried out inside a clean room that completely shuts out all dust by using three levels of anti-contamination protection. Professor Fujikawa and his team felt great jubilation at finding so many particles and verifying their origin as Itokawa. NASA curators and scientists following the progress of the operations also showed their delight with the results by exclaiming, "Excellent!" on hearing the news.

For Professor Fujimura, who began his scientific career researching rocks exposed to high temperature and high pressure deep inside the Earth's mantle and then moved to specialize in planetary science, as well as for many people throughout Japan, the results from the Hayabusa capsule were the conclusion of a long wait. At last there was confirmation that a major scientific breakthrough had been achieved—for the first time humankind had obtained material from a celestial body much farther away than the Moon.



*Particles observed using an optical microscope*




*Rocky particles whose origin was identified as being Asteroid Itokawa*

*The maximum number of people allowed inside the clean room at any one time is 10. This commemorative photo-graph of researchers involved in sample handling was taken in front of the clean chamber using a camera self-timer.*

# Astronaut Soichi Noguchi's 163 days in space

## Aiming to contribute to the expansion of humankind's space activities

At 12:25 p.m. on June 2, 2010 (Japan Standard Time; from hereon referred to as JST), JAXA Astronaut Soichi Noguchi touched down back on Earth after completing his 163-day long-duration mission in space. In this article, we recap the main mission activities undertaken by Astronaut Noguchi during his stay on the ISS and provide background information on the significance of those activities.


*Astronaut Noguchi's personal logo for Expedition 22/23*

# Three objectives of Astronaut Noguchi's long-endurance space mission

*The mission patch for ISS flight 21S / Soyuz TMA-17*

*The Expedition 23 crew patch*

Astronaut Noguchi was a crew member of expeditions 22 and 23 to the ISS, serving as a flight engineer on a long-duration mission. He spent 161 days on the ISS and a total of 163 days in space.

For Astronaut Noguchi, this long-endurance mission carried three main objectives. First, Astronaut Noguchi would be tasked with carrying out scientific experiments in the space environment and any new scientific discoveries or knowledge resulting from these experiments would later be applied in various industrial fields. Second, through the operation of JEM (Japanese Experimental Module) Kibo—one of the ISS' modules—Japan would acquire the international-level technological capabilities and know-how necessary for manned space flight missions. Third, envisaging a future where large numbers of people engage in space travel and space living, the practical results of this long-endurance mission would contribute to the expansion of the scope of humankind's activities in space.

Carrying these three objectives, Astronaut Noguchi lifted off from the Baikonur Cosmodrome in Kazakhstan at 6:52 a.m. on December 21, 2009, aboard Soyuz TMA-17 together with two other crew members from the United States and the Russian Federation. Two days later, on December 23, their spacecraft docked with the ISS.

During his stay on the ISS, Astronaut Noguchi assembled the Small Fine Arm (SFA) of the JEM Remote Manipulator System (RMS), participated in the day-to-day operation and maintenance of the ISS, and carried out a range of scientific experiments that utilized the space environment. In April 2010, Astronaut Noguchi and JAXA Astronaut Naoko Yamazaki, who traveled to the ISS aboard Space Shuttle Discovery, worked together to transfer materials between the Discovery and the ISS. Astronaut Noguchi safely concluded his long-endurance mission when he returned to Earth on June 2, 2010.

*Astronaut Noguchi pays a courtesy visit to Japanese Prime Minister Naoto Kan at his official residence.*

*From left, JAXA Astronaut Soichi Noguchi, Roscosmos Cosmonaut Oleg Kotov, and NASA Astronaut Timothy Creamer participate in the official ceremony held to welcome their mission back to Earth.*

*At a post-mission briefing, Astronaut Noguchi (second from left) explains an image of Earth he took from the ISS Cupola Module (observation dome).*

*A selection of photographs taken by Astronaut Noguchi, which he posted to the Twitter micro-blogging service, are shown on pages 14 and 15.*

## Mission Preparation and Progress ▸▸ Pre-flight Training

©JAXA/NASA

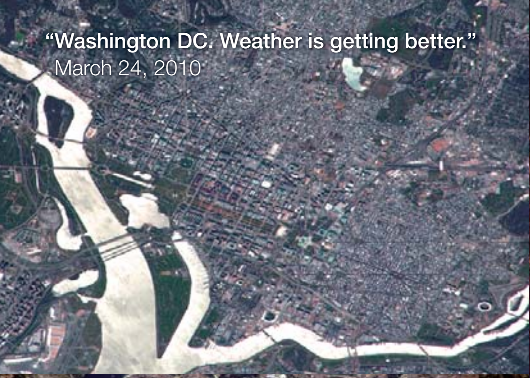
Conducting ISS emergency evacuation training

©JAXA/NASA

Operating the Space Station Remote Manipulator System (SSRMS) in a simulator

©JAXA/NASA

Undertaking spacewalk—or extra-vehicular activity (EVA)—training in a pool at NASA Johnson Space Center



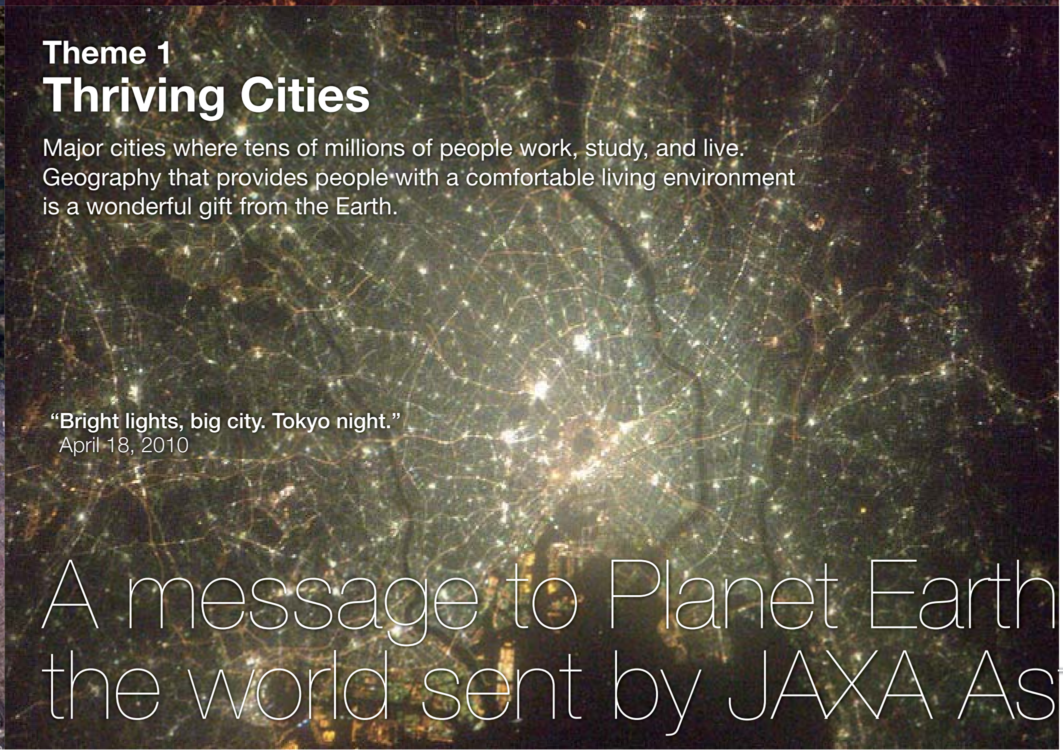
"Washington DC. Weather is getting better."
March 24, 2010

"Golden rings of Moscow, Russia. Happy Victory Day weekend!"
April 30, 2010

"I spy a big tower! Paris, France."
April 30, 2010

"Ponte Vasco da Gama, near Lisbon, Portugal. The longest bridge in Europe."
May 18, 2010

"Big 'eye' looking straight up! Mexico."
March 12, 2010



## Theme 1
# Thriving Cities

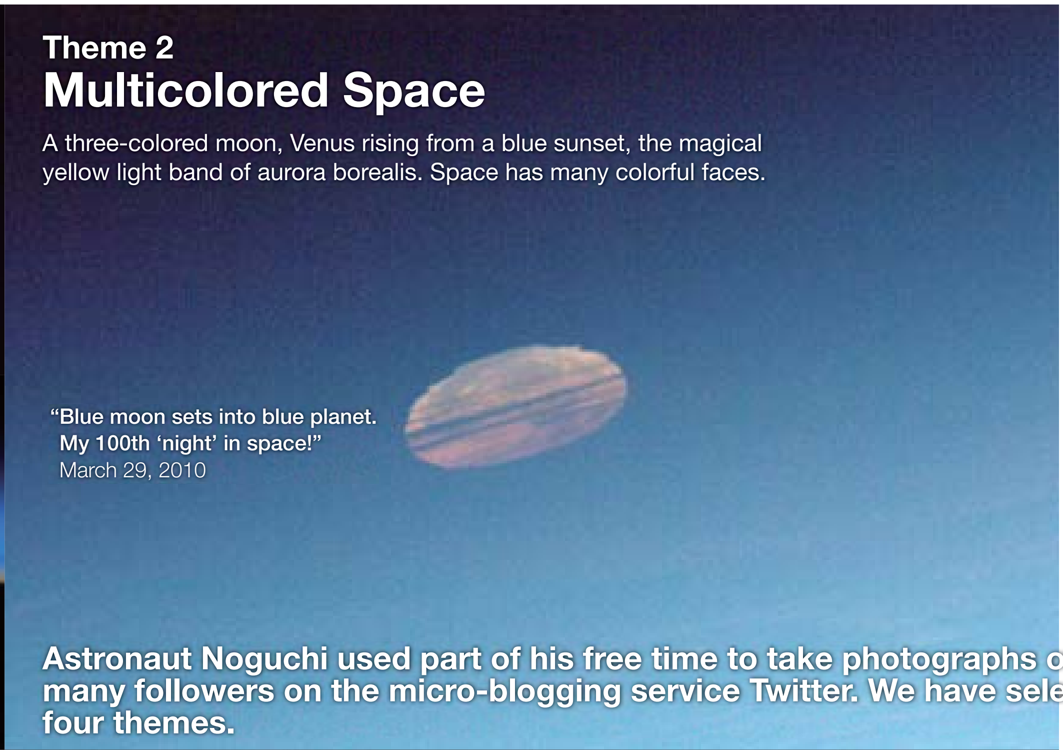
Major cities where tens of millions of people work, study, and live. Geography that provides people with a comfortable living environment is a wonderful gift from the Earth.

"Bright lights, big city. Tokyo night."
April 18, 2010

A message to Planet Earth
the world sent by JAXA As

"My favorite 14th moon."
April 28, 2010

"Venus and sunset."
February 26, 2010



## Theme 2
# Multicolored Space

A three-colored moon, Venus rising from a blue sunset, the magical yellow light band of aurora borealis. Space has many colorful faces.

"Blue moon sets into blue planet. My 100th 'night' in space!"
March 29, 2010

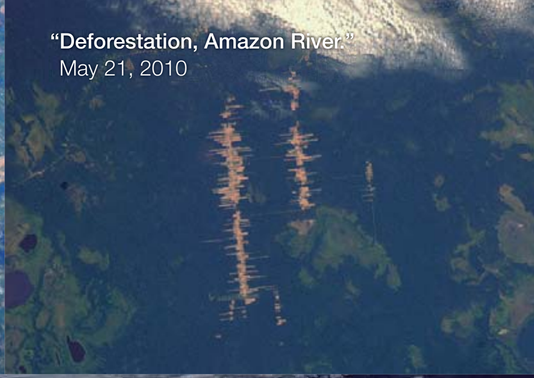
**Astronaut Noguchi used part of his free time to take photographs o many followers on the micro-blogging service Twitter. We have sele four themes.**

"Aurora. Northern Europe."
March 9, 2010

"View of the round earth from Cupola."
April 25, 2010

"Moon tonight. Sleep well!"
March 26, 2010


"Flooding in east Europe. Our thoughts and prayers, and hope for the earliest recovery."
May 4, 2010


"Deforestation, Amazon River."
May 21, 2010


"Port-au-Prince, Haiti. Three months after the earthquake."
April 10, 2010

### Theme 3
## Vulnerable Lands and Oceans

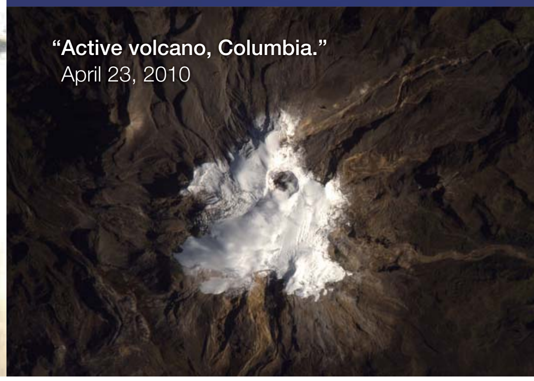
The view from space shows us with our own eyes the huge impact of environmental destruction and natural disasters.


"Oil spill in Gulf of Mexico, USA."
May 4, 2010

and to all the people of
tronaut Soichi Noguchi




"Volcano in Caribbean islands."
March 20, 2010


"Active volcano, Columbia."
April 23, 2010

### Theme 4
## A Planet of Water, Snow, and Ice

Water seems to take on myriad forms all over the Earth as it nurtures a rich array of life forms.

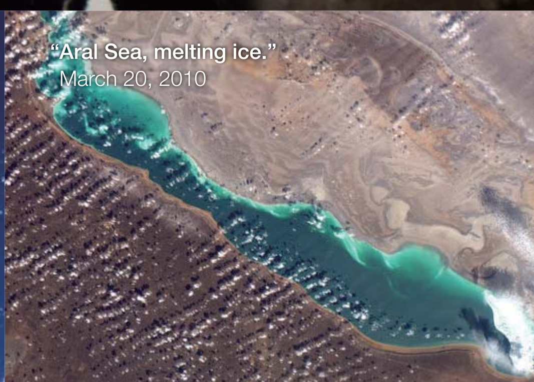

"Big iceberg! The 'calculated' actual size is five miles wide!!! Indian Ocean."
March 5, 2010

**f the Earth and send these images along with messages to his**
**cted a sample of these photographs and arranged them into**


"Mt. Fuji, Japan. On the morning of my 100th day in orbit :-)"
March 30, 2010

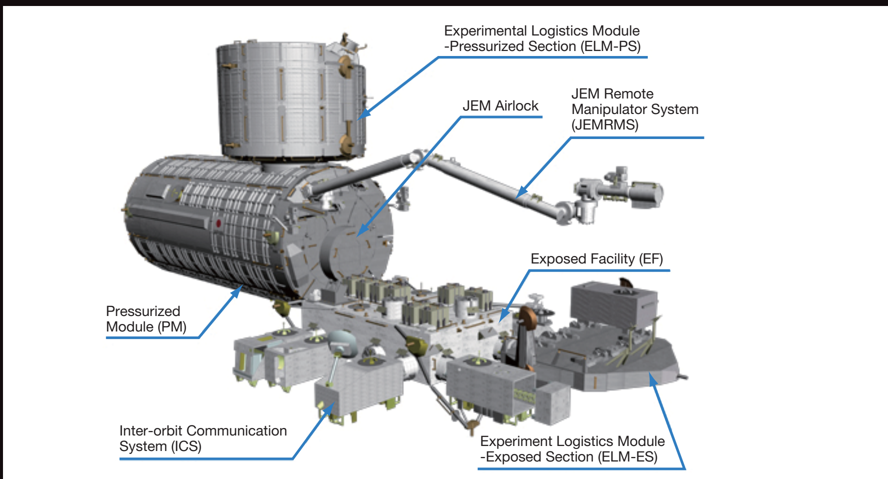

"Glacier lake in Southern Patagonia. See the color difference between the two lakes."
March 4, 2010


"Chatham Islands, New Zealand."
April 24, 2010


"Aral Sea, melting ice."
March 20, 2010


"Sahara. Desert is beautiful!"
March 17, 2010

# Theme 1: Completing the basic functions of JEM Kibo




*Japan's first manned space activities facility*

## Assembly of the SFA for JEM Kibo's robotic arm

JEM Kibo is equipped with a robotic arm called JEMRMS, which is used for such tasks as exchanging payloads on the module's Exposed Facility (EF). The system comprises the Main Arm (MA) and the SFA, which attaches to the end effector of the MA, and the JEMRMS Console, which is the system's control workstation. One of the tasks assigned to Astronaut Noguchi was the assembly of the SFA (Small Fine Arm) and its attachment to the MA. In September 2009, the SFA was transported to the ISS in a disassembled state inside the H-II Transfer Vehicle (HTV) technology-demonstration spacecraft.

In January 2010, Astronaut Noguchi and Commander Jeffrey Williams of NASA assembled the SFA and stowed it in the airlock of JEM Kibo's Pressurized Module (PM), ready for its attachment to the MA. An airlock is a passageway that enables the movement of people and materials between two environments of differing air pressure. The air pressure in the airlock is equalized with the pressure in the area to be entered before the hatch is opened. The airlock on JEM Kibo is used exclusively for the passage of materials and equipment.

In March 2010, Astronaut Noguchi and NASA Flight Engineer Timothy Creamer operated the MA to transfer the SFA from the airlock to the EF. After attaching the SFA to the MA and testing that its functions were working, the SFA was installed on the SFA Stowage Equipment (SSE), which is part of the EF platform. This operation marked the completion of installation of all JEM Kibo system equipment and meant that all basic functions of the module were now in place.


*Assembly of the SFA*

## Flight Day 1

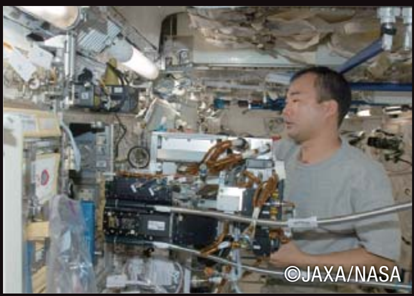

Noguchi, Kotov, and Creamer enter Soyuz TMA-17 for final pre-launch checks.


The liftoff of Soyuz TMA-17

## Flight Day 3


Soyuz TMA-17 (ISS flight 21S) approaches the ISS.

# Theme 2: A diverse array of scientific experiments



*In the Fluid Physics Experiment Facility (FPEF), performing repairs on apparatus used in the "Space-time Structure in Marangoni Convection" experiment*

## Astronaut Noguchi worked on numerous scientific experiments.

In JEM Kibo's PM, there are currently a large number of experiments under way in pure science fields (material science, life science), applied fields, and in the space medicine field. During his long-duration mission on the ISS, Astronaut Noguchi worked on a total of 12 experiments that are being managed by JAXA. The following is an overview of the main experiment themes.

**Space-time structure in Marangoni convection:** Acquisition of basic data with the aim of elucidating the Marangoni convection mechanism (the content of this experiment differs slightly from the experiment introduced on page 23, titled "Chaos, Turbulence and its Transition Process in Marangoni Convection").

**Elucidation of a new mechanism of muscular atrophy mediated by ubiquitin ligase Cbl-b:** Identifying a new mechanism whereby a muscle protein (Cbl-b) mediates muscular atrophy

**Nanoskeleton synthesis in the microgravity environment:** Production in space of high-performance structures at the nano level (nanoskeleton), which could not be achieved on the ground

## Repair of laboratory instruments

During the performance of one of the abovementioned experiments, "Space-time structure in Marangoni convection," in November 2009 it was found that silicone oil being used in the experiment was leaking from a gap between components in a laboratory instrument. The experiment was temporarily suspended and from January 13 to 15, 2010, Astronaut Noguchi carried out on-orbit repairs. Although this difficult operation required the application of polyvinyl acetate (PVA) glue to a tiny 50µm gap, Astronaut Noguchi successfully completed the repair thanks to close cooperation with ground personnel. Subsequently, Astronaut Noguchi verified that the silicone oil was no longer leaking and the experiment was resumed in late January.

*Performing repairs on apparatus used in the Marangoni convection experiments in JEM Kibo's Pressurized Module (PM)*

## Flight Day 3

Astronaut Noguchi enters the ISS through the hatch of TMA-17.

## Flight Day 6

Cleaning duties in JEM Kibo's PM

## Flight Day 9

In JEM Kibo's PM, working on the Minus Eighty Degree Celsius Laboratory Freezer for ISS (MELFI)

# Theme 3: Life in space

## Space living that emphasizes daily routines

What kind of daily lives do astronauts lead on the ISS, which is not only their workplace but also their "home in space"? The ISS crew—including Astronaut Noguchi during his mission—lead a regular daily routine based on Greenwich Mean Time (GMT) and organized according to a highly structured schedule. The crew members' two-hour daily routine of physical training uses a variety of exercise machines and equipment for aerobic exercise and strength training, which are essential for preventing the loss of muscle strength and bone mass.

### A typical weekday activity schedule followed by Astronaut Noguchi aboard the ISS

| | |
|---|---|
| Sleep | |
| Breakfast (1 hour) | |
| | Face wash, etc. (30 minutes) |
| Planning conference with mission control (2 hours) | |
| Mission tasks (total: approximately 8 hours) | |
| Lunch (1.5 hours) | |
| Mission tasks | |
| Physical exercise (2 hours) | |
| Dinner (1 hour) | |
| Free time (1 hour) | |
| Sleep (approximately 7 hours) | |

## Astronauts relax in their personal quarters

Previously, only meals produced in the United States and Russia were sent to the ISS. However, in 2008, the menu was expanded to include Japanese-made space meals, so that astronauts may now enjoy such items as green tea, pork curry, and *ramen* noodles.

In the area of personal hygiene, although there is no shower aboard the ISS, astronauts receive such supplies as soap, shampoo, razor blades, and toothbrushes, and they can even cut their hair with electric clippers, which are equipped with a suction device to catch the clippings.

Each crew member is assigned his or her own personal quarters for sleeping, getting dressed and spending their allotted free time. In the personal quarters, in addition to a warning and alarm system, an air-conditioning unit and sleeping bag, astronauts also have their own personal computer. Astronaut Noguchi used the Sleep Station installed within JEM Kibo's PM as his personal quarters, attaching his nameplate to the door during his stay.

Although Astronaut Noguchi used part of his free time on this mission to pursue Zen Buddhism-inspired "space meditation" for the first time, he found that it was difficult to remain in a still position owing to the microgravity environment, which resulted in his floating about inside JEM Kibo and sometimes banging into objects.


*Using the Advanced Resistive Exercise Device (ARED) during a physical workout*

## Flight Day 39


In Columbus, the European Space Agency's (ESA) science laboratory module, performing work related to ESA experiments

## Flight Day 59


President Obama talks to the ISS crew (photographed at the White House).

## Flight Day 115


A group photo of the Space Shuttle Discovery STS-131 crew and Expedition 23 crew in JEM Kibo

# Theme 4: Publicity programs designed to bring space closer to our everyday lives on Earth

**Astronaut Noguchi participated in the following public relations (PR) events during his long-endurance mission on the ISS.**

## Communication session with then Prime Minister Mr. Yukio Hatoyama (January 7, 2010)

At the Prime Minister's official residence, under the guidance of JAXA Astronaut Satoshi Furukawa, then Prime Minister Mr. Yukio Hatoyama, then Minister of Education, Culture, Sports, Science and Technology Mr. Tatsuo Kawabata, and pupils from Hamasuga Elementary School in Chigasaki, Kanagawa Astronaut Noguchi's former school participated in a 25-minute communication session with Astronaut Noguchi.

## Fun space experiments (March 6 and May 2, 2010)

Utilizing the ISS' microgravity environment, during two sessions in March and May 2010, Astronaut Noguchi participated in a video project called "Fun Space Experiments," which aims to provide educational materials for use in school classrooms. The session in March included experiments to demonstrate certain laws of physics, including conservation of momentum and action and reaction. The former experiment involved the collision of rolls of packing tape while the latter experiment utilized bags of water. The session in May demonstrated the mechanism of rocket propulsion using rubber gloves and explained Bernoulli's principle—one of the fundamentals on which aircraft flight is based— using a food container. Astronaut Noguchi used a wide variety of equipment found inside the ISS to explain some of the basic principles of physics in easy-to-understand terms.

## Real-time communication event (May 5, 2010)

JAXA held an educational event in which students chosen from locations throughout Japan were given the opportunity to put questions directly to Astronaut Noguchi. The question and answer session utilized a real-time linkup provided through Japan's independent Inter-Orbit Communication System (ICS) between JEM Kibo and the JAXA Tsukuba Space Center (TKSC).


*Then Prime Minister Mr. Hatoyama asks Astronaut Noguchi about his stay on the ISS.*


*The law of action and reaction: A water bag (approximately 45 liters) with a cord attached is stopped stationary in midair. Astronaut Noguchi pulls on the cord to draw the bag closer. Whereupon, not only is the bag drawn toward Noguchi, but Noguchi moves also, pulled by the bag.*

## Flight Day 148


Working in the Unity module (Node 1)

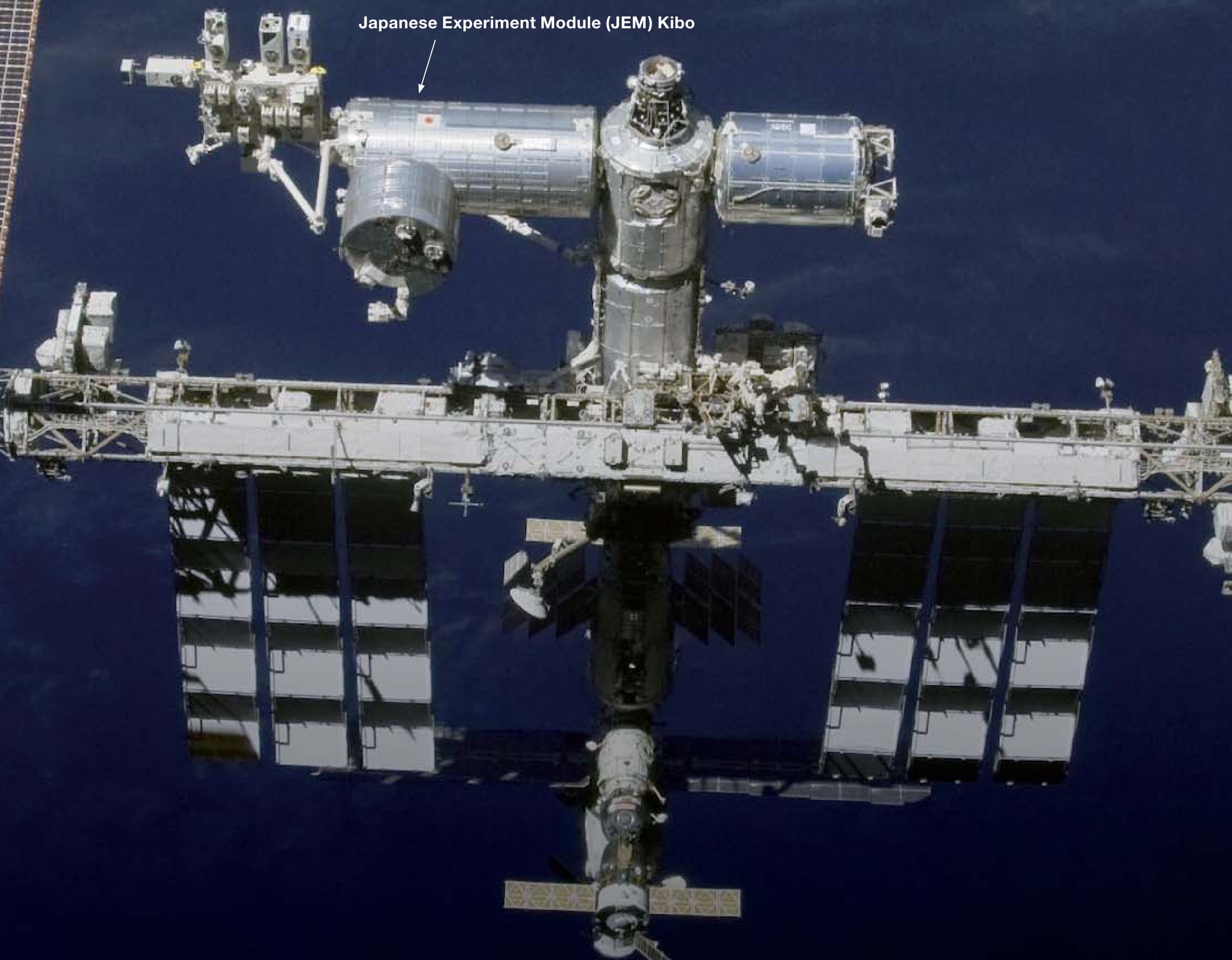
## Flight Day 163


The Soyuz TMA-17 spacecraft approaches touchdown near the town of Zhezkazgan, Kazakhstan, on June 2, 2010.

## Flight Day 163


Immediately after landing

# Expanding the frontiers of scientific discovery aboard the Japanese Experiment Module (JEM) Kibo




The Japanese Experiment Module (JEM) Kibo is one of the modules attached to the International Space Station (ISS). As Japan's first manned experiment facility in space, JEM Kibo's assembly was completed in July 2009. Utilizing the unique characteristics of its space environment—including microgravity, high vacuum, expansive field of vision, cosmic radiation, and abundant solar energy—experiments covering a diverse range of scientific fields are conducted aboard JEM Kibo's Pressurized Module (PM). In this article, four principal investigators introduce their respective experiment projects.

# 1 Aiming for the development of therapeutic drugs for Duchenne muscular dystrophy (DMD)

## High Quality Protein Crystallization Research (HQPC)

Experiment period: February–June 2010
Principal investigator: Dr. Yoshihiro URADE, Osaka Bioscience Institute

### 1. Objective

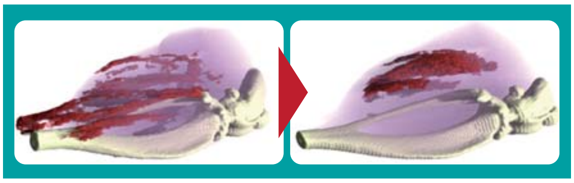
One of the objectives of HQPC is to contribute to the development of pharmaceutical drugs that will be effective by binding onto disease-related proteins. The structure through which the drug and protein bind is analogous to the relationship between a key and keyhole. If we understand the detail of the keyhole (protein), we will be able to develop a key (drug) to fit it. We are carrying out research relating to therapeutic treatments for DMD, which causes muscle wasting and loss of muscle strength. As a part of this research, I conducted space experiments with the aim of synthesizing compounds to inhibit the action of a protein called prostaglandin D synthase, which has been found to aggravate the muscular inflammation in DMD patients.

### 2. Method

In the microgravity environment of space, it is possible to grow higher-quality protein crystals than on Earth. We analyzed the high-quality crystals of prostaglandin D synthase grown in the Protein Crystallization Research Facility (PCRF) and synthesized compounds that would bind with the catalytic site of prostaglandin D synthase. We were able to identify the detail of the binding mechanism and the three-dimensional structure of the binding site of the compounds to the protein. These compounds will become therapeutic drug candidates for use with DMD patients.

### 3. Principal results and future prospects

At present, based on the results of this experiment, we are pursuing the development of therapeutic drugs in collaboration with a pharmaceutical company. In Japan, owing to the relatively small number of DMD patients—approximately 3,000 people—the development of such a drug is extremely difficult from a commercial perspective. Particularly in such cases as this—in the field of orphan drugs (drugs to treat rare disorders)—I believe that the involvement of a publicly funded agency such as JAXA is very significant.



*The illustration above provides a graphical representation of how muscle atrophy (shown in red) is reduced by the treatment with a synthesized compound, which is a therapeutic drug candidate for DMD patients.*

# 2 Investigating the effects of cosmic radiation on human health with the aim of making safe long stays in space possible

## Gene Expression of *p53*-regulated Genes in Mammalian Cultured Cells after Exposure to Space Environment (Rad Gene)

Experiment period: February 2009
Principal investigator: Takeo OHNISHI, Special Chair in Radiation Oncology, School of Medicine, Nara Medical University

### 1. Objective

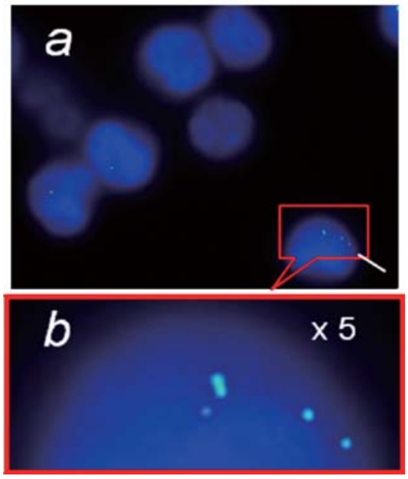
When humans are exposed to cosmic radiation, damage occurs to cellular DNA, which can sometimes lead to carcinogenesis. The *p53* molecule—a product of the tumor suppressor *p53* gene—repairs DNA damage or eliminates mutated cells through apoptosis. It is also a key enzyme from the point of view of cancer research. In this experiment, we took living human lymphoblastoid into the space environment and observed how the *p53* gene functions.

### 2. Method

Four frozen lymphoblastoid samples were taken into Kibo's Cell Biology Experiment Facility (CBEF), and after thawing, two samples were cultured in each of the microgravity compartment and the 1G compartment (in which the Earth's gravity is simulated using centrifugal force) for approximately one week. In each gravity environment, one sample comprised cells with normal *p53* genes while the other sample comprised cells with abnormal (mutant) *p53* genes. By comparing the two pairs of samples, we were able to isolate the effects of cosmic radiation and also the effects of microgravity on the *p53* gene expression by use of DNA arrays. After the culture process was completed, the cells were frozen again and brought back to Earth.

### 3. Principal results and future prospects

This experiment achieved a world first by successfully providing a visualization of the DNA damage caused by cosmic radiation. In addition, we measured the amount of cosmic radiation that caused the DNA damage as a biological dosimetry. These results will be useful in the future—for example, in the case of manned missions to Mars—in devising ways to protect astronauts from the harmful effects of cosmic radiation, thereby making it possible for humans to spend long periods of time in space safely.




*DNA damaged by cosmic radiation. The cell nuclei are dyed dark blue and the DNA double strand breaks are dyed pale blue. The white line in Figure a indicates the direction of cosmic radiation. Figure b is an enlargement of the indicated portion of Figure a.*

# 3 Deciphering plant life cycles in space

## Life Cycle of Higher Plants under Microgravity Conditions (Space Seed)

**Experiment period:** September–November 2009
**Principal investigator:** Seiichiro KAMISAKA, Visiting Professor, Graduate School of Science and Engineering, University of Toyama; Professor Emeritus, Osaka City University

### 1. Objective

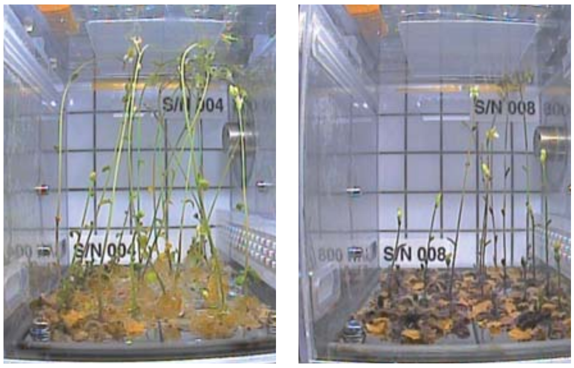
In the space environment lacking gravity, we grew plants over a complete life cycle—including seed germination, leaf and stalk growth, pollination, embryogenesis, and seed formation—and investigated whether or not we could produce next-generation seeds.

### 2. Method

We grew Arabidopsis thaliana (thale cress) inside plastic chambers within Japanese Plant Experiment Units (PEUs). Although thale cress has a relatively short life cycle, it still takes about two months from seed germination to the seed formation of the next generation. For this reason, it is an experiment that could only be carried out on the ISS where long-duration missions are possible. Eight PEUs were taken into Kibo's CBEF (Cell Biology Experiment Facility), with four PEUs each placed in the microgravity compartment and 1G compartment. The plant life cycle was then monitored remotely by our experiment team back on Earth.

### 3. Principal results and future prospects

We observed that the foliage patterns differed between the two compartments. In the 1G artificial gravity compartment, the foliage spread out radially at the bottom of the chamber, while in the microgravity compartment, the foliage pointed upward. In addition, in the microgravity compartment, the timing of the aging represented by the change in leaf color from green to brown was delayed, suggesting that ethylene—a plant hormone—is involved in the delay of aging. If humans were to live in space in the future, they would have to rely on plants both as a food source and for environmental maintenance. The data obtained by this experiment are likely to contribute to a basic set of data for plant cultivation in space.




*Arabidopsis thaliana plants growing in the microgravity compartment (left) and the 1G compartment (right)*
*© University of Toyama / JAXA*

## 4 Elucidating the mechanisms that govern the oscillatory Marangoni flow with a view to contributing to the fields of material science and semiconductor crystal growth

### Chaos, Turbulence and its Transition Process in Marangoni Convection (Marangoni Experiment in Space / MEIS)

**Experiment period:** Experiments conducted in five series from MEIS-1to MEIS-5
MEIS-1: August–October 2008 MEIS-2: July–August 2009
MEIS-3: October 26–December 22, 2010
MEIS-4: September 2011 (planned) MEIS-5: To be confirmed

**Principal investigator:** Koichi NISHINO, Professor, Faculty of Engineering, Yokohama National University (YNU)

#### 1. Objective

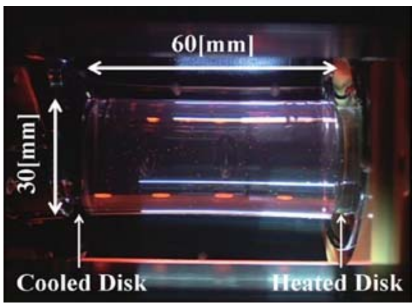
Marangoni convection, which arises due to differences in the surface tension along gas-liquid interfaces, occurs in various industrial fields, such as semiconductor crystal growth and heat pipes used for heat dissipation in computers. Marangoni convection can affect the quality of silicon crystals and heat-dissipation performance. The objective of this experiment was to clarify the conditions for the onset of oscillatory Marangoni convection. On the ground, it is difficult to observe the effects of Marangoni convection since they are masked by the stronger effects of thermal convection (buoyancy convection) caused by gravity. For this reason, it is useful to conduct experiments in space in a microgravity environment.

#### 2. Method

We selected silicon oil as a working liquid and conducted MEIS-1 and MEIS-2 in the Fluid Physics Experiment Facility (FPEF) aboard Kibo. In MEIS-1, we successfully generated a large silicon-oil bridge between two disks heated differentially. This liquid bridge measured 30mm in diameter and 60mm in length—much larger than would be possible on the ground. We made various observations of the characteristics of oscillatory Marangoni convection in this liquid bridge. In MEIS-2, we carried out more sophisticated measurements of the evolution of flow patterns and the surface velocity in the liquid bridge.

#### 3. Principal results and future prospects

In MEIS-3, which commenced in October 2010, we will create a liquid bridge that has a 50mm diameter and observe the effects of silicon oil viscosity on Marangoni convection. We will further elucidate the properties of Marangoni convection and we hope that this research will contribute significantly to increased sophistication in semiconductor crystal growth and heat-pipe design.




*A liquid bridge of silicon oil formed between two disks of differing temperature*
*© JAXA/YNU*

# JAXA's frontier

Their Majesties the Emperor and Empress receive explanations about Hayabusa from project manager Professor Jun'ichiro Kawaguchi.
© Ibaraki Prefecture

## Their Majesties the Emperor and Empress view the Hayabusa capsule

On August 1, 2010, Their Majesties the Emperor and Empress visited the Tsukuba Space Center to view the capsule returned to Earth by the asteroid explorer Hayabusa. While viewing the actual heat shield used in Hayabusa and other exhibits, Their Majesties asked questions and followed with keen interest explanations provided by project manager Professor Jun'ichiro Kawaguchi about the capsule and other aspects of the mission.

Astronaut Soichi Noguchi (right) and Astronaut Naoko Yamazaki (wearing a light blue kimono) chat with His Majesty the Emperor at the Autumn Garden Party.
© The Imperial Household Agency

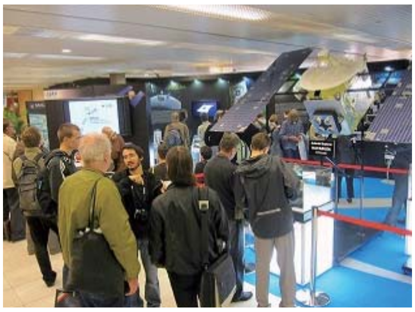
## JAXA astronauts Soichi Noguchi and Naoko Yamazaki attend Autumn Garden Party given by Their Majesties the Emperor and Empress

On the occasion of the Autumn Garden Party given by Their Majesties the Emperor and Empress at the Akasaka Imperial Gardens in Tokyo on October 28, 2010, JAXA Astronauts Soichi Noguchi and Naoko Yamazaki were among the invited guests. Astronaut Yamazaki smiled as she spoke to His Majesty the Emperor, saying "It was truly a pleasure to successfully complete my mission thanks to the support of everyone in Japan."

President Tachikawa (at the lectern on the far right hand side) reports on JAXA's current programs.

## 61st International Astronautical Congress (IAC) held in Prague

The 61st IAC was held in Prague, the Czech Republic, from September 27 to October 1, 2010. At the opening ceremony, International Astronautical Federation (IAF) President Berndt Feuerbacher introduced the return of Hayabusa as the leading space development accomplishment of 2010 and also mentioned the success of IKAROS. JAXA President Keiji Tachikawa participated in the Heads of Agency (HOA) plenary, reporting on such developments as the successful launches of Quasi-Zenith Satellite-1 (Michibiki). JAXA's exhibition booth attracted a large number of visitors and featured a well-received video presentation about the Hayabusa sample-return capsule.



JAXA's exhibition booth at the IAC, which drew approximately 1,500 visitors

## His Imperial Highness the Crown Prince and His Royal Highness Prince Willem-Alexander of the Netherlands visit the Tsukuba Space Center

On September 14, 2010, His Imperial Highness the Crown Prince and His Royal Highness Prince Willem-Alexander of the Netherlands visited the Tsukuba Space Center. The Crown Prince and Prince Willem-Alexander share a particular interest in water management and conservation issues, and they were given explanations relating to the use of satellite technology to monitor and manage water resources. They also viewed a protoflight model* (PFM) of GCOM-W1, a satellite currently being assembled whose mission will be to provide observation data on changes in the Earth's water cycle. In the Control Room for the Japanese Experiment Module (JEM) Kibo, a module of the International Space Station (ISS), the Crown Prince and Prince Willem-Alexander received an explanation from JAXA Astronaut Chiaki Mukai about facilities used on the ISS, including the water-recycling system.

* A protoflight model is tested to confirm that there are no problems in the satellite's design and that its workmanship meets the quality requirements of a flight model. The protoflight model subsequently becomes the flight model and is launched.

The Crown Prince and Prince Willem-Alexander receive an explanation from Astronaut Chiaki Mukai.
© The Yomiuri Shimbun

## International Academy of Astronautics (IAA) marks 50th anniversary by holding Heads of Space Agencies Summit

On November 17, 2010, the IAA hosted a landmark Heads of Space Agencies Summit on the occasion of its 50th anniversary in Washington, D.C., gathering together over 500 participants, comprising academicians, world leaders, and experts. The summit brought together 30 heads of space agencies from around the world, providing an opportunity to affirm the importance of close global collaboration in such areas as human spaceflight, planetary robotic exploration, disaster management and climate change. Each space agency leader spoke at the summit, and when JAXA President Keiji Tachikawa mentioned the success of Hayabusa in returning a sample of particles confirmed to be from Asteroid Itokawa there was applause from all of the agency heads and the audience.

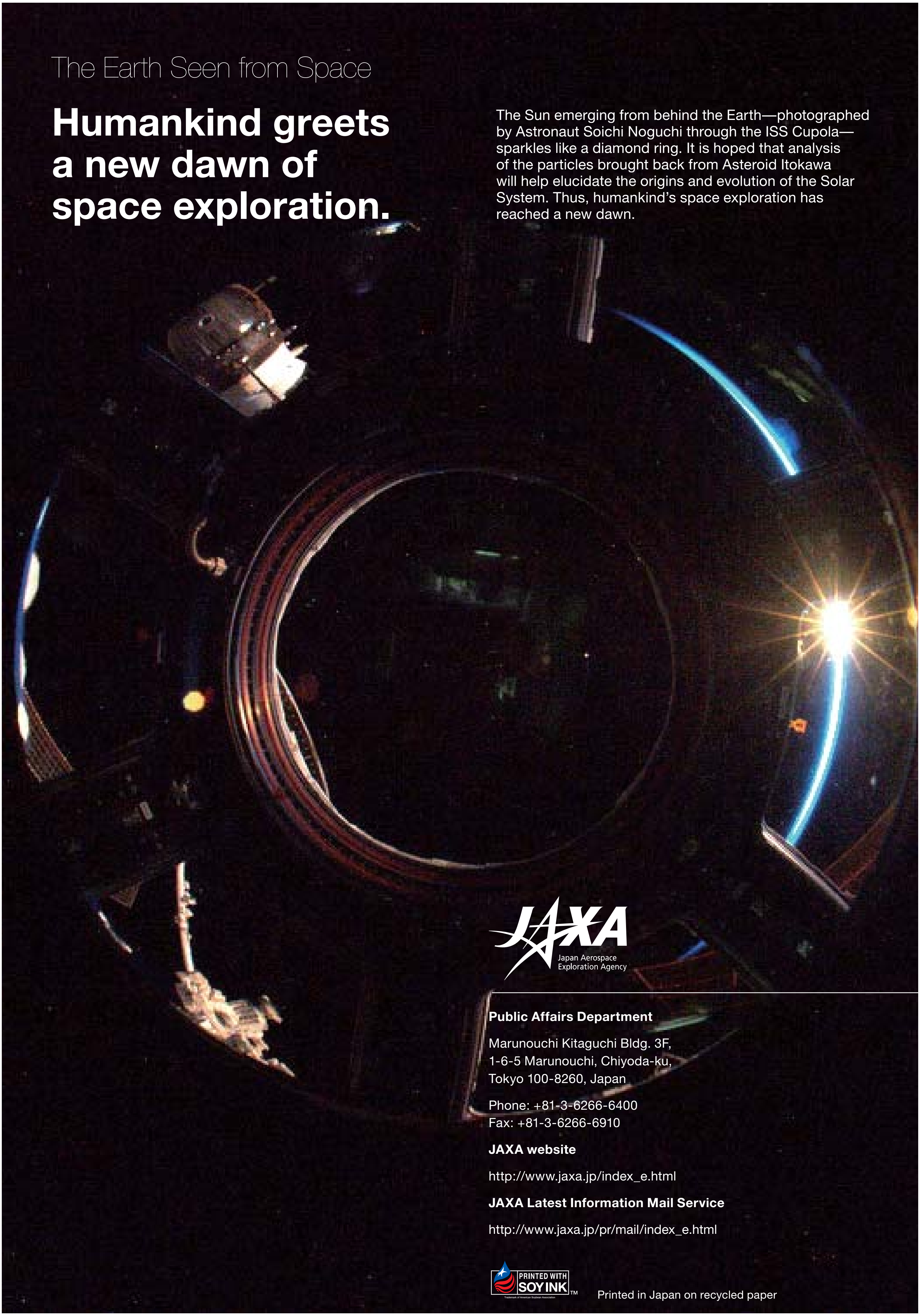
President Keiji Tachikawa (far right hand side) gives a speech to the summit, including a report of the results of the Hayabusa mission.

## Melbourne, Australia, hosts the 17th Session of the Asia-Pacific Regional Space Agency Forum (APRSAF-17)

The 17th Session of the Asia-Pacific Regional Space Agency Forum (APRSAF-17) was held in Melbourne, Australia, November 23–26, 2010. The meeting attracted more than 200 participants, who were mainly drawn from various governmental and space agencies in the Asia-Pacific region. APRSAF-17 adopted the theme of "the role of space technology and industry in addressing climate change," which formed the basis for vigorous discussions. With regard to addressing climate change, the meeting included presentations introducing JAXA's programs in the field of climate change observation as well as case studies utilizing satellite observation data.


APRSAF-17 participants representing space agencies and other organizations from across the Asia-Pacific region

APRSAF official website
http://www.aprsaf.org/



The Earth Seen from Space

# Humankind greets a new dawn of space exploration.

The Sun emerging from behind the Earth—photographed by Astronaut Soichi Noguchi through the ISS Cupola—sparkles like a diamond ring. It is hoped that analysis of the particles brought back from Asteroid Itokawa will help elucidate the origins and evolution of the Solar System. Thus, humankind's space exploration has reached a new dawn.

JAXA
Japan Aerospace Exploration Agency

**Public Affairs Department**

Marunouchi Kitaguchi Bldg. 3F,
1-6-5 Marunouchi, Chiyoda-ku,
Tokyo 100-8260, Japan

Phone: +81-3-6266-6400
Fax: +81-3-6266-6910

**JAXA website**

http://www.jaxa.jp/index_e.html

**JAXA Latest Information Mail Service**

http://www.jaxa.jp/pr/mail/index_e.html

PRINTED WITH SOY INK™

Printed in Japan on recycled paper