f. International Top Young Fellowship

Since FY2009, ISAS has offered the JAXA International Top Young Fellowship (ITYF) program as part of its initiatives to make Japan a leading member of the most advanced space science community. The program calls for the participation of young and promising researchers from across the world, and successful applicants are invited to Japan for a predetermined assignment term. It is a popular program, with the open call applicants significantly outnumbering the available places every year. Fellows invited through this program stay Japan on a three-year term, which can be extended to five years after review. The program was recognized in the FY2012 JAXA international external evaluation as "highly effective in promoting ISAS's presence and in contributing to the advancement of space science."

A total of 15 fellows have participated in the program so far, six of whom have since taken permanent posts in other institutes and universities. For FY2017, three new fellows were selected. ITYF fellows are encouraged to become involved in other projects as well as to pursue their own studies. These opportunities are expected to have a synergistic effect through interactions between the fellows and Japanese researchers at ISAS. Much as previous fellows have contributed to remarkable outcomes in the projects in which they were involved, our current fellows are not only making proactive contributions to ongoing projects, but are also actively engaged in forming future projects.

ITYF Fellows (as of March 31, 2018)

Name	Former Institute	Research Theme	Period
PERALTA, Javier	Instituto de Astrofísica de Andalucía (Spain)	Characterization of atmospheric dynamics by using "AKATSUKI" and "Venus Express"	April 2015 -
CRITES, Sarah	University of Hawaii at Manoa (US)	Evolution of the Solar System as Revealed by Remote Sensing of Small Bodies	July 2016-
IZUMI, Kiwamu	California Institute of Technology (US)	Observational gravitational wave astronomy	September 2017-
BONARDI, Stéphane	Massachusetts Institute of Technology (US)	Self-reconfigurable modular robots for space exploration: design and control	October 2017-
QUINTERO NODA, Carlos	Solar-B Project Research Associate/ JAXA	New insights on solar polarimetry as preparation for future solar missions: Sunrise/SCIP	November 2017-

The following shows ITYF fellows in FY2017 and their published research:

PERALTA, Javier
Research Highlights in FY 2017

The atmosphere of Venus exhibits a remarkable spin that, at the region of the upper clouds (65-70 km above surface), can reach velocities sixty times faster than the underlying surface as measured on dayside images. This phenomenon, called superrotation, is not satisfactorily explained yet and most of Venus's atmospheric models fail to reproduce it accurately. Interestingly, the atmospheric circulation of Venus at the superrotating upper level has not been studied on the night side, except at the polar region. In our paper "Stationary Waves and Slow Motions in the Upper Clouds of Venus" (Nature Astronomy, 1, id. 0187 [2017]) we report the first measurements of the night side global atmospheric circulation of Venus at the upper cloud level (60-70 km) by tracking the apparent motions of cloud features in thermal emission images at 3.8 and 5.0 µm, taken during 2006-2008 by the VIRTIS instrument onboard ESA's Venus Express, and in 2015 with the SpeX instrument on NASA's IRTF telescope. Our results contradict expectations of finding superrotating motions similar to the dayside, finding a wider temporal variability which affects both the motions and the morphology of clouds. Unexpectedly, the nocturnal upper clouds exhibit morphologies different to the dayside and abundant stationary features which we interpret as gravity waves and are strongly correlated with the surface elevations. These mixed results (stationary waves and episodes of weaker motions) imply new and exciting challenges for present Venus's General Circulation Models, and are expected to provide valuable insights towards explaining the atmospheric superrotation of Venus. Our work was highlighted in the section "News and Views" of Nature Astronomy ("Venus: Tickling the clouds" Nature Astronomy, 1,0198 [2017]), as well as in ESA and JAXA press sections, and in diverse media.

Published research in FY2017:

- J. Peralta et al., Geophysical Research Letters, Vol.44 (8), pp.3907-3915 (2017) doi: 10.1002/2017GL072900
- J. Peralta et al., Icarus, Vol. 288, pp. 235-239 (2017) doi: 10.1016/j.icarus.2017.01.027
- J. Peralta et al., Nature Astronomy, Vol. 1, 0187 (2017) doi: 10.1038/s41550-017-0187
- T. Horinouchi et al., Nature Geoscience, Vol. 10, pp. 646-651 (2017) doi: 10.1038/ngeo3016
- T. Horinouchi et al., Earth, Planets and Space, Vol.70, 10 (2018) doi: 10.1186/s40623-017-0775-3
- S. Pérez-Hoyos et al., Journal of Geophysical Research: Planets, Vol. 123(1), pp.145-162 (2018) doi: 10.1002/2017JE005406
- S. S. Limaye et al., Earth, Planets and Space, vol.70, 24 (2018) doi:10.1186/s40623-018-0789-5

CRITES, Sarah

Research Highlights in FY2017

In a paper submitted to Nature Geoscience, I along with ISAS collaborators R. Ballouz and N. Baresi describe our discovery of a new mechanism that shapes the surface of Mars' moon Phobos, and can explain its two enigmatic geological units: eccentricity-driven cold flow of grains. Phobos' surface is defined by two major geologic units, the red unit (defined by a low albedo and increasing visible to infrared continuum slope) and the blue unit (defined by higher albedo and flatter spectral slope). Despite decades of observations, the origin and relationship of the two units remains ambiguous: the red unit could be formed through space weathering of the blue unit; or the two units could be compositionally distinct. Here we show that although Phobos' orbital eccentricity is small (e~0.0151), it leads to variations in the tidal force that causes mass motion whose accumulated effect over time leads to the transformation of the red space-weathered surface, exposing blue sub-surface material and explaining the spatial distribution of blue and red materials. We modeled the effect of Phobos' slight eccentricity (0.0151) and found that induced librations cause surface slopes to vary by up to 2 degrees every orbital period (7.65 hours). Coupled with simulations of Phobos' regolith, we show that this time-varying effect leads to gradual erosion. Furthermore, visible and near-IR imaging and spectroscopy from spacecraftshow that blue units are correlated with high-slope regions that experience moderate-to-high variations, where our model predicts the highest erosion rates. These results demonstrate a new mechanism where spectrally immature blue material is continually refreshed by mass wasting in certain regions (analogous to the tidally-induced refreshing of asteroid surfaces), while space weathering alters the rest of the surface into red material. This new insight into geologic processes on Phobos demonstrate that with the in-situ and laboratory measurements that the Martian Moons eXploration (MMX) mission will enable, this moon may become a "Rosetta Stone" for understanding space weathering throughout the solar system. Furthermore, our work provides additional constraints on the ongoing debate of Phobos' origin: if, as our mechanism suggests, the blue unit represents pristine, endogenous Phobos material, then impact-origin scenarios that suggest Phobos is Mars-like must explain the lack of expected spectral absorption features in the blue units.

Published research in FY2017:

- T. Kaku et al., Geophysical Research Letters, Vol.44 (20), pp.10155-10161 (2017). doi:10.1002/2017GL074998

IZUMI, Kiwamu

Research Highlights in FY2017

In this past year, my research has been chiefly focused on two different items; one is an experimental effort of bringing the Japanese ground-based gravitational-wave detector, KAGRA, online as quick as possible. The other is to seek for possible collaboration with the LISA (Laser Interferometer Space Antenna) mission of ESA in the context of their detector design and operation.

KAGRA currently proceeds with its installation in multiple steps and active commissioning tests between the major installation steps with the aim of operating the full interferometer at some point in 2019 to join the global detector network. In this past year, the goal was set to operate a 3-km Michelson interferometer with either one of or both the end mirrors kept at a cryogenic temperature of 20 K. This will mark a big milestone of achieving a km-scale laser interferometric gravitational-wave detector operating at a cryogenic temperature for the first time in the history. As a sub-lead of the commissioning team there, I lead various experimental activities on site including the design of analog and digital electronics, preparation of the necessary automation software, and physically aligning the core optics to deliver the main interferometer laser light to both end mirrors with a precision of tens of micro radians. A detailed summary of the operation of the 3-km Michelson interferometer will be reported shortly in a journal paper.

As for the activity of seeking for possible collaboration with LISA, I have attended a meeting called LISA science study team meeting held at Glasgow, UK at the end of this past March. As a representative of ISAS/JAXA, I expressed our interest that we are looking for possible contributions to the LISA mission. I accordingly started collecting the technical aspects of the mission payload design and their associated software preparation to decide on what topic we may be able to assist. I will keep in contact with the LISA project throughout the fiscal year of 2018 as well to further pursue this topic.

BONARDI, Stéphane
Research Highlights in FY2017

Since I arrived at ISAS in October 2017, I have been working on developing innovative robotic solutions for planetary exploration and future space colonization. Together with my supervisor, we have chosen to divide this topic into three main parts: advanced mobility, autonomous self-adaptation, and human-robot collaboration, focusing on one aspect per year.

My current subject of research is centered around the topic of dynamic mobility of groups of Momentum Driven Robots (MDR) in complex environments. I am working on integrating and controlling compliant elements in structures made of MDR. I am using bio-inspired techniques (Central Pattern Generators, among others) and fast relearning methods to control these structures. The large number of control parameters is one of the main challenges in this approach along with the integration of the complex sensory feedbacks into the control loop. I am developing new simulation models that I will soon calibrate during hardware experiments. These models rely on real time Finite Element Analysis (FEA) to model the compliant elements and flexible components of the robotic systems. I am planning to test my approach with colleagues from the Tsukuba research center and from my previous lab at MIT using the platforms that they developed (Int-Ball and M-Blocks, respectively).

The next step of my work will focus on the autonomous adaptation of the robotic structure to the task to be performed. I have recently submitted a KAKENHI grant for fostering joint international research together with partners from EPFL (Switzerland) and MIT (USA) to explore these topics in depth. I am also restarting a collaboration I had in the past with Tohoku University (Prof. Ishiguro) on the topic of agile locomotion using bioinspired sensory feedback.

QUINTERO NODA, Carlos
Research Highlights in FY2017

This research is divided in two main topics. On the one hand, I am working with data taken with JAXA's HINODE (formerly Solar-B) satellite and ground-based telescopes for understanding how the magnetic field configuration of solar sunspots triggers different solar eruptive phenomena. This is done applying numerical codes that allow improving the observations and inferring the physical information of the solar lower atmosphere. On the other hand, I continue characterizing different regions of the solar spectrum to determine which are the most capable solar spectral lines for future missions, in particular, for the Sunrise Chromospheric Infrared spectro-Polarimeter (SCIP), an instrument led by Japan in a consortium that includes Germany and Spain as international partners. SCIP will perform observations for more than 10 days at stratospheric heights on board the Sunrise balloon-borne telescope, with a scheduled launch in 2021. The results of those studies indicate that the infrared lines at 850 nm are able to detect acoustic shocks and oscillatory plasma motions at different atmospheric layers allowing to seamlessly trace the solar phenomena in the lower-middle atmosphere. Moreover, the spectral window at 850 nm can be complemented with different spectral lines that have access to additional solar atmospheric layers, as the ones included in the infrared region at 770 nm. This spectral region, severely affected by telluric absorption, can be entirely observed for the first time thanks to the possibilities offered by the Sunrise stratospheric balloon that flies at an average altitude of 35 km. This is because, similar to satellites, we avoid most of the telluric atmospheric absorption and we can observe solar lines that otherwise are completely blocked at ground level. Thus, we have found through those publications an optimum design for understanding the solar phenomena, mainly at low atmospheric heights where we expect to find the roots of the solar eruptive events. This design will be implemented on the Sunrise/ SCIP instrument, funded by the JAXA small scale project program and the Grants-in-Aid for Scientific Research (KAKENHI) program, to perform novel observations in the near future. These observations will help us to unravel some of the oldest mysteries about the Sun and to fully understand their impact in our daily life at Earth.

Published research in FY2017:

- C. Quintero Noda et al., Astronomy & Astrophysics, Vol. 610, A79 8 pp. (2018) doi:10.1051/0004-6361/201732111
- C. Quintero Noda et al., Monthly Notices of the Royal Astronomical Society, Vol. 470 (2), pp. 1453-1461 (2017) doi:10.1093/mnras/stx1344
- C. Quintero Noda et al., Monthly Notices of the Royal Astronomical Society, Vol. 472 (1), pp. 727-737 (2017) doi:10.1093/mnras/stx2022
- L. Bharti et al., Solar Physics, 293 (3), art. no. 46 (2018) doi: 10.1007/s11207-018-1265-x
- D. Orozco Suarez, et al., Astronomy & Astrophysics, Vol. 607, A102. (2017) doi:10.1051/0004-6361/201731216
- T. Oba, et al., The Astrophysical Journal, Volume 849, Issue 1, article id. 7, 11 pp. (2017) doi: 10.3847/1538-4357/aa8e44