

WORKSHOP #7

WORKSHOP TITLE: A new era in sample return missions: Synchrotron analysis opportunities beyond Earth materials

Organizers: Tim Glotch (Stony Brook University), George Flynn (SUNY Plattsburgh), Paul Northrup (Stony Brook University), Mehmet Yesiltas (Kirkklareli University)

The historical value and scientific impact of extraterrestrial sample return has been profoundly demonstrated by discoveries from the Apollo, Stardust, Genesis, Hayabusa, and Hayabusa2 missions. The NASA LARS (Laboratory Analysis of Returned Samples) program was created to develop the instrumentation required to maximize the science return from these unique samples and to support their analysis following mission completion. It continues to actively fund both measurements and infrastructure development; construction of the NSLS-II TES beamline was partly funded by LARS. As we move into a new era of sample-retrieval missions, from the near-Earth asteroid Bennu, the Martian moon Phobos, Earth's Moon, and Mars, we eagerly anticipate new opportunities to study these materials using unique synchrotron-based tools -- particularly those at NSLS-II.

Japan's Hayabusa2 mission recently returned 5.4g of samples from the asteroid Ryugu, and two grains were initially measured at NSLS-II XFM and TES. The NASA OSIRIS-REx mission has collected samples from asteroid Bennu and will return with its payload in September 2023. The Artemis III and subsequent missions will provide new samples from the Moon's south pole. Other missions to return samples from Phobos and the surface of a comet have been proposed or are in development. The Perseverance rover on Mars is gathering samples for eventual retrieval to Earth. Each of these missions offers unprecedented opportunities to study materials not previously available on Earth, and synchrotron-based measurements are ideal tools for the study of such precious samples. Synchrotron techniques include imaging and absorption spectroscopy at multiple spatial scales and probe wavelengths, bulk and microbeam XRD, micro-IR and nano-IR, and advanced scattering techniques. Multimodal approaches, combining multiple synchrotron techniques with lab-based electron microscopy and spectroscopy techniques including Raman, can be used to characterize the chemical, physical, and structural details of these materials. These types of coordinated analysis campaigns will help us better understand the makeup of the Solar System beyond our home planet, and the prospects for life elsewhere. These approaches also provide unique insight into the processes by which the Solar System formed and evolved to its present state.

Start Time (ET)	Title	Speaker (Affiliation)
9:30	Introduction and welcome	Organizers
9:40	The historical value of sample return: examples of results from Apollo, Stardust, Genesis, and Hayabusa. The NASA LARS Program	George Flynn (SUNY Plattsburgh)
10:10	Microscopy and spectroscopy of returned asteroid samples: Ryugu	Yoko Kebukawa (Yokohama National University)
10:30	Hayabusa mission: characterization of Itokawa particles	Masayuki Uesugi (JASRI)

10:50	STXM of extraterrestrial materials: In case of Hayabusa2 returned sample	Motoo Ito (JAMSTEC), Takuji Ohigashi (KEK), Hayato Yuzawa (UVSOR/IMS) and Masayuki Uesugi (JASRI/SPring-8).
11:10	“Overview of the MMX sample return mission.”	Ryota Fukai (JAXA)
11:30	Overview of the OSIRIS REx sample return mission	Thomas Zega (Arizona)
12:00	Group Discussion: sample prospects and timelines	
12:20	Lunch and networking	
1:30	Hayabusa2 mission: Multimodal, multi-scale characterization of Ryugu samples	Tim Glotch (Stony Brook University)
2:00	Ryugu Particles Contain Sulfur in Multiple Oxidation States	Maitrayee Bose, (Arizona State University), Robert A. Root (University of AZ), Thomas Redford (University of Hawaii, Manoa), and Jacob Eaton (ASU)
2:20	Non-invasive X-ray microprobe characterization of chemistry in Ryugu grains: pink beam CT and tender-energy microspectroscopy	Paul Northrup (Stony Brook University), Ryan Tappero (NSLS-II)
2:50	Micro-Raman imaging of Ryugu sections correlated with synchrotron microprobes and IR	Mehmet Yesiltas (Kirkklareli University)
3:10	Coffee Break and networking	
3:25	Analysis options for future Mars samples	Joel Hurowitz (Stony Brook University) and Juergen Thieme (NSLS-II)
3:45	Group Discussion: Beamline challenges and adaptations for handling and mounting, making non- or minimally-invasive measurements, and coordinating multi-modal studies, of return-mission samples	Organizers and Participants
4:15	Closing discussion: Opportunities and needs for the user community	Organizers and Participants
4:30	Adjourn	