

SPHERES

Synchronized, Position, Hold, Engage, Reorient,
Experimental Satellites



SPHERES/Astrobee Working Group (SAWG) Quarterly Meeting

March 20th, 2019





Agenda

Agenda Free-Flyer Working Group:

- NASA Ames, SPHERES/Astrobee Facility, Jose Benavides
- JAXA, Int-Ball, Doi-san
- Airbus/DLR, CIMON, Christian Karrasch
- MBIE research, Chris Hann
- Open Discussion

Agenda SAWG:

- NASA SPHERES/Astrobee Facility
- MIT
- Stanford
- NASA REALM-2
- Astrobotic
- NPS
- FIT



SPHERES Community

□ SPHERES Working Group (SWG) Quarterly meeting

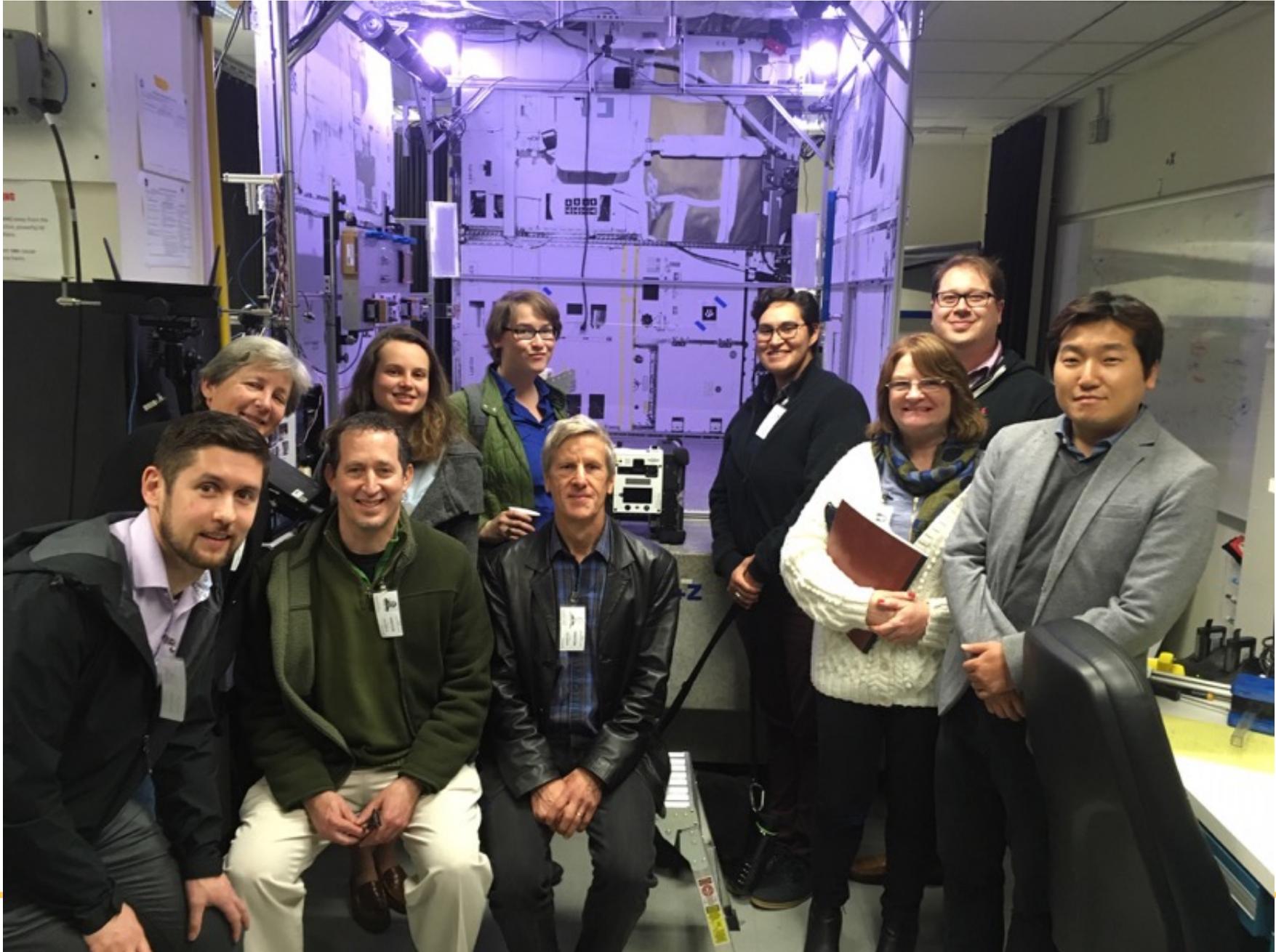
- Membership includes MIT, FIT, AFS, DARPA, CASIS, Airbus, and NASA (HQ, KSC, JSC, MSFC, and ARC)
- Face-to-Face, twice a year
- Next will be scheduled on March 2019, location: Telecon

□ Purpose:

- Information sharing across the SPHERES/Astrobee community
 - Astrobee Facility shares
 - ✓ National Lab Facility availability
 - ✓ Status of resources (batteries, CO2 tanks, etc.),
 - ✓ Overall Calendar (scheduled Test Sessions, upmass/return), and
 - ✓ Updates on “new” PD, Investigations, and ISS infrastructure.
 - Provide the SPHERES/Astrobee community (PD, investigators, etc.) with up-to-date information to determine opportunities to use the NL Facility
 - Discuss proposed changes/updates to Astrobee Nat Lab which may be required to support a specific activity or research.
 - Discuss specific support requests made to the ISS Office
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SPHERES Community





Guest Science Program (GSP)

- ❑ What's available from the Astrobee Facility?
 - ❑ Astrobee Robotics Software Simulation
 - ❑ Ground Hardware: Qty 3 & "Flat-Sats"
 - ❑ Labs: Granite & MGTF
 - ❑ Documentation and Training
 - ❑ Proposal Support
 - ❑ ISS Payload Partner
- ❑ How can I use Astrobee and what does it take?
 - ❑ **Guest Scientist Guide** & Mechanical Payload ICD
 - ❑ New Hardware or "just" Software?
 - ❑ Ground Demonstration or ISS Operation?
- ❑ Information found on website

<https://www.nasa.gov/astrobee>



Guest Scientists

- ❑ Replacing SPHERES, it is anticipated that Astrobees will carry on as the **most highly utilized payload on the ISS**

- ❑ 7 Projects actively working towards ISS payloads
 - Zero Robotics (MIT)
 - Astrobatics (Naval Postgraduate School)
 - SoundSee (Astrobotic/Bosch)
 - Gecko (Stanford)
 - RFID Seeker (NASA REALM)
 - JAXA joint activity
 - [Port Tester]



Astrobees guest scientist institutions in the US

- ❑ **Ground Studies**
 - FIT/RINGS
 - Tethers Unlimited
 - NK Labs
 - NMSU



Highlights

- ❑ Astrobees build complete and prepared for launch!
- ❑ SPHERES Test Sessions
 - ❑ Smooth-Nav Science 4 (MIT, 2/27)
 - ❑ High School Zero Robotics Finals (MIT, 01/28)
- ❑ SPHERES GUI submitted to PSIVF for ISS Zbook laptop transition
- ❑ JAXA joint activity planning on-going, Tokyo visit Feb. 11th
- ❑ Astrobees user testing at Ames
 - ❑ REALM Testing
 - ❑ Gecko Testing



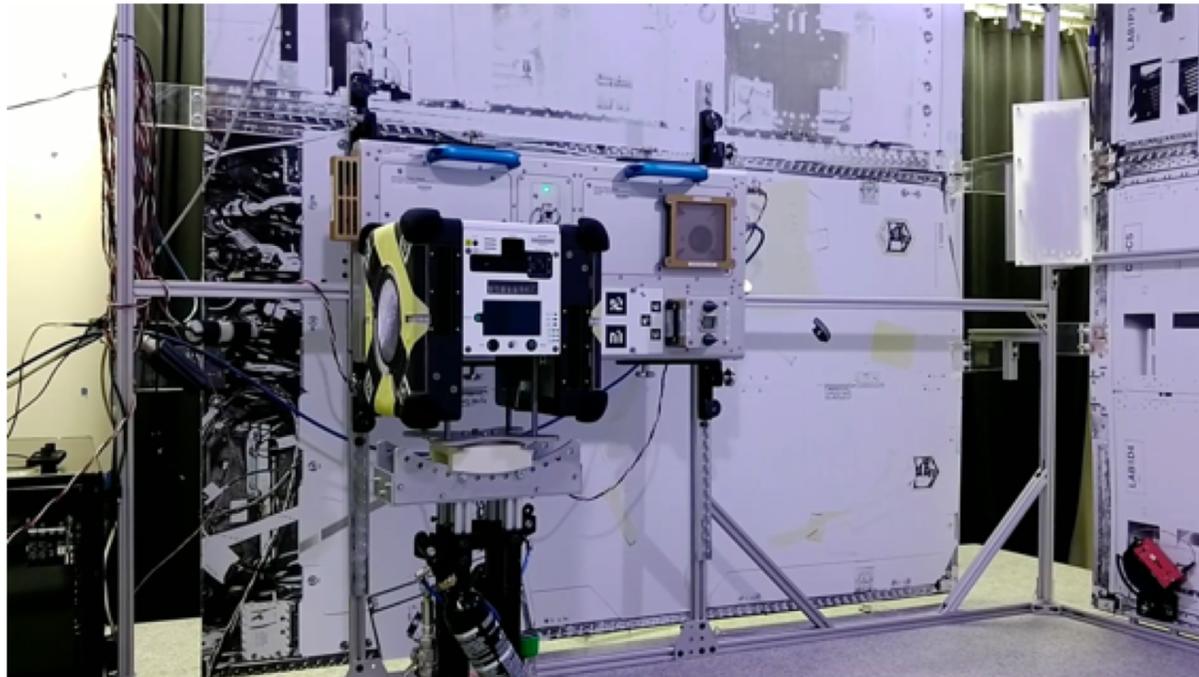
Astrobee at JAXA, Feb. 2019





What's next ...

- ❑ Next ZR competition is under way, Finals in August 2019
- ❑ Continuing SPHERES-ReSWARM
- ❑ **Continue work transitioning to Astrobee**
 - ❑ Goal: Fully operational in 2019
 - ❑ SPHERES to Astrobee ISS handoff activity
- ❑ Astrobee and Int-Ball joint-activity discussions continuing





SPHERES Engineering



MGTF





SPHERES & Astrobee Operations



Increments 57/58 (since last SWG 12.12.18)

➤ SPHERES Test Sessions

- Zero Robotics High School Dry Run - January 14, 2019
- Zero Robotics High School Finals - January 28, 2019 – Successful use of the 3D printed hook!
- SmoothNav Science 4 (final session for this investigation) – February 27
 - Unfortunately the data was not properly downloaded, data is still on ISS; we need to build a session to recover the data

➤ Astrobees Commissioning Activities

- Astrobees Docking Station Installation Prep Activity – February 11, 2019
- Astrobees Docking Station Installation Activity – February 15, 2019

➤ Astrobees Ops Planning

- Astrobees Unit 1 “Checkout” ops products in development- delivery February 15
- Astrobees Unit 1 “Calibration and Mapping” ops products in development- delivery February 15



Increments 59/60 Look Ahead

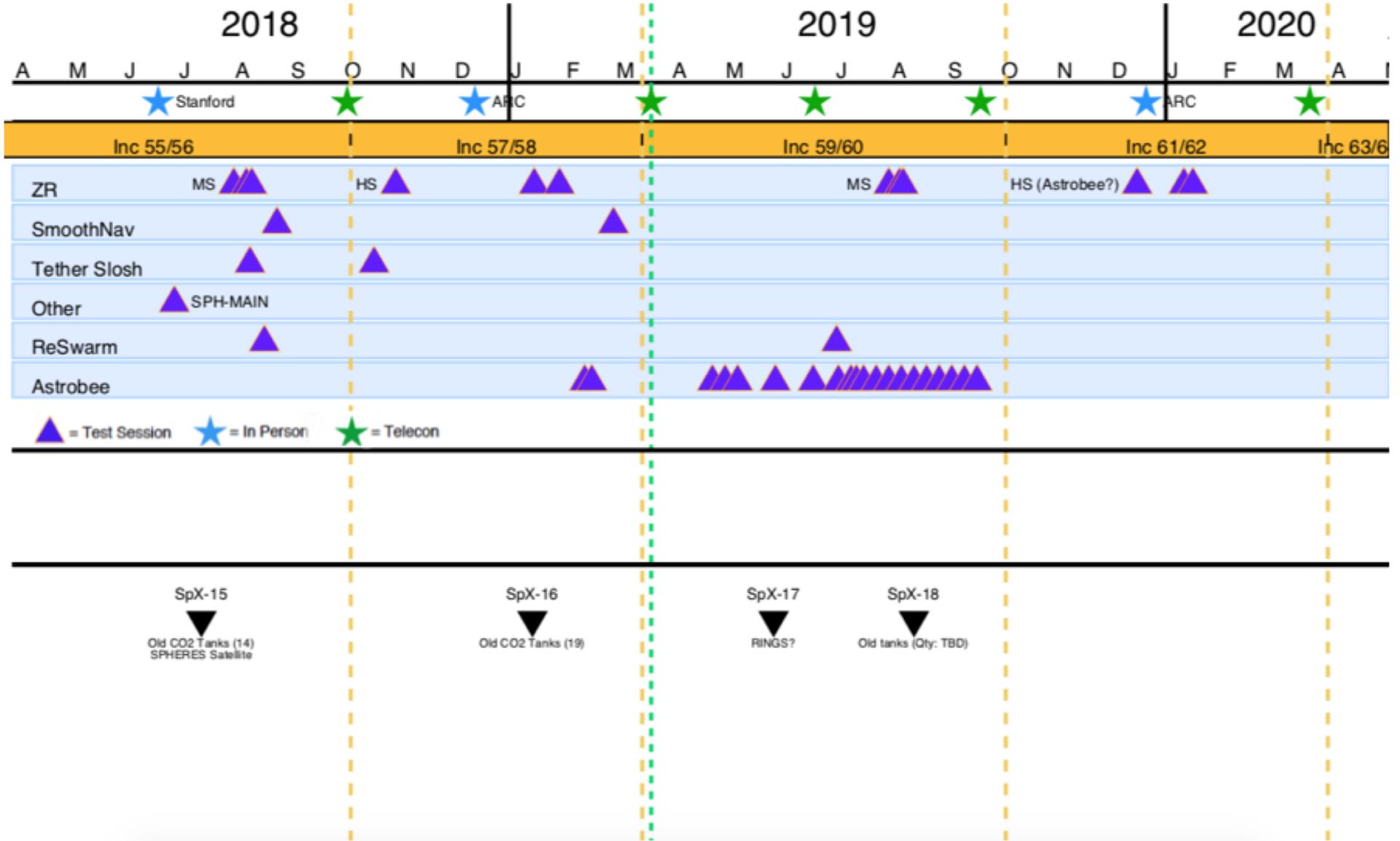
ASTROBEE		
#	Event/Activity/Task/Session Description	Template Date(s) & Flexibility
1	Dock Software Update	4/2/2019 +/- 1 week
2	Honey Bee Checkout	4/30/2019, +1 week
3	Honey Bee Calibration & Mapping	5/7/2019, + 1 week
4	Honey Bee Localization/Basic Mobility	5/28/2019, + 1 week
5	Honey Bee Localization/Basic Mobility	6/18/2019, + 1 week
6	Honey Bee Autonomous Mobility	7/02/2019, + 1 week
7	Crew interface	7/09/2019, + 1 week
8	Ops Demo	7/12/2019, + 1 week
9	Bumble Bee Checkout/Calibration	7/16/2019, + 1 week
10	Bumble Bee Localization/Basic Mobility	7/23/2019, + 1 week
11	Bumble Bee Autonomous Mobility	7/30/2019, + 1 week
12	Payload Installation	8/6/2019, + 1 week
13	Queen Bee Checkout/Calibration	8/13/2019, + 1 week
14	Performance Characterization 1	8/20/2019, + 1 week
15	Performance Characterization 2	8/27/2019, + 1 week
16	Queen Bee Localization/Basic Mobility	9/3/2019, + 1 week
17	Queen Bee Autonomous Mobility	9/10/2019, + 1 week
18	SPHERES/Astrobee Hand-off	9/17/2019, + 1 week

SPHERES

- ☐ Zero Robotics Middle School Units Test
 - July 2019
- ☐ Zero Robotics Middle School Dry Run
 - August 2019
- ☐ Zero Robotics Middle School Finals
 - August 2019
- ☐ ReSwarm Science 2
 - Summer 2019 TBD



SPHERES Calendar





Safety-Verification & Consumables

CO2 Tank Inventory

- 45 Tanks on orbit – will easily support remaining sessions (~25 needed)

Battery Pack Inventory

- 15 Batteries on orbit - should support remaining sessions
- 10 SPHERES Rechargeable Batteries – checked out and used several times

Consumables downmass

- 19 empty gray tanks returned on SpX-16
- Planning to return empty gray tanks on SpX-18



SPHERES & Astrobee on Social Media

The screenshot shows the NASA SPHERES website. At the top is the NASA logo and a navigation menu with links for Topics, Missions, Galleries, NASA TV, Follow NASA, Downloads, About, and NASA Audiences. A search bar is also present. Below the navigation is a large banner image of three SPHERES satellites (blue, red, and orange) with the word "SPHERES" in large white letters. Underneath the banner is a sub-menu with "Ames Research Center" selected, and links for Overview, Images, Videos, and Media Resources. On the left side, there is a "Follow" section with social media icons for Facebook, Twitter, Google+, YouTube, and Instagram. Below these are links for SPHERES Home, Mission Overview, History, Satellites and Facilities, Partners and Affiliates, Guest Scientist Program, SPHERES Publications, FAQ, Archived Science, and SPHERES Working Group. The main content area features three articles: "Tether Slush" with an image of two men working on a satellite, "SPHERES Shatters Own Record For Highest Operating Tempo in" with an image of a satellite in space, and "SPHERES Zero Robotics High School 2016" with an image of a student using a laptop. A "Tweets by @NASA_SPHERES" section is visible at the bottom right of the page.

Twitter

https://twitter.com/NASA_SPHERES

Website

<http://www.nasa.gov/spheres>

<http://www.nasa.gov/astrobee>