Bonnie J. Buratti, SBAG Steering Committee Chair

November 16, 2021 NASA Planetary Science Advisory Committee (PAC)
Virtual Meeting

www.lpi.usra.edu/sbag/

The Steering Committee

Present Steering Committee (Green new)

Justin Atchison (JHU/APL) Technology Lead
Maitrayee Bose (Arizona State Univ.)
Bonnie Buratti (NASA JPL/Caltech), Chair
Michael Busch (SETI Inst.)
Terik Daly (APL), Early Career Secretary
Jessie Dotson (NASA Ames), Planetary Defense Lead
Henry Hsieh (Planetary Science Institute)
Mihaly Horanyi (Univ. of Colorado, Boulder)
Stephanie Jarmak (SWRI) Early Career Secretary (2.5 year term)
Stefanie Milam (NASA GSFC)
William O'Hara (Sierra Nevada Corp.), Human Exploration Lead
Jennifer Scully (NASA JPL/Caltech)
Timothy Titus (USGS, Flagstaff)

Steering Committee selects Chair and Steering Committee members from among nominations, applications. General membership open.

SBAG Representatives

Thomas Statler NASA Headquarters Liaison
Jake Bleacher Human Exploration and Operations Mission Directorate (HEOMD) Liaison
Paul Abell (JSC) HEOMD Observer

Next Meeting (virtual)

January 24-25, 2022

Other activity (Dec 1, 2021):

A request from the Committee on Planetary Protection (CoPP), a discipline committee of the Space Studies Board of the National Academy of Sciences: SBAG's perspective on Potential Contamination of Small Bodies. Stefanie Milam has agreed to give the talk.

Key Recent Findings

ARECIBO SCIENCE RECOVERY

1. **SBAG recommends that NASA support additional asteroid radar observations at other facilities in order to meet a portion of the scientific and planetary defense goals previously accomplished by the Arecibo Observatory.** These steps are outlined in a white paper (https://www.lpi.usra.edu/sbag/documents/SBAG_RadarRecovery_20210217.pdf) (Summary follows these findings in backup slide.)

2. **SBAG also recommends that NASA continue to consult with NSF and/or other relevant agencies about the Arecibo collapse and the process for deciding what happens next with the site, in order to ensure that the implications for NEO observations are adequately included.**

(Full text at https://www.lpi.usra.edu/sbag/findings/)

Small Body Radar Updates

Goldstone has observed 35 near-Earth asteroids in 2021. Several more are scheduled by Dec. 31.

33 NEAs are scheduled in 2022 including targets for the *DART* (Didymos) and *Janus* (1996 FG3) missions.

Delivery of a spare klystron is scheduled in 2022. A second spare klystron has been ordered.

Installation of new transmitter hardware planned in 2025. Modernizes old components (not klystrons).

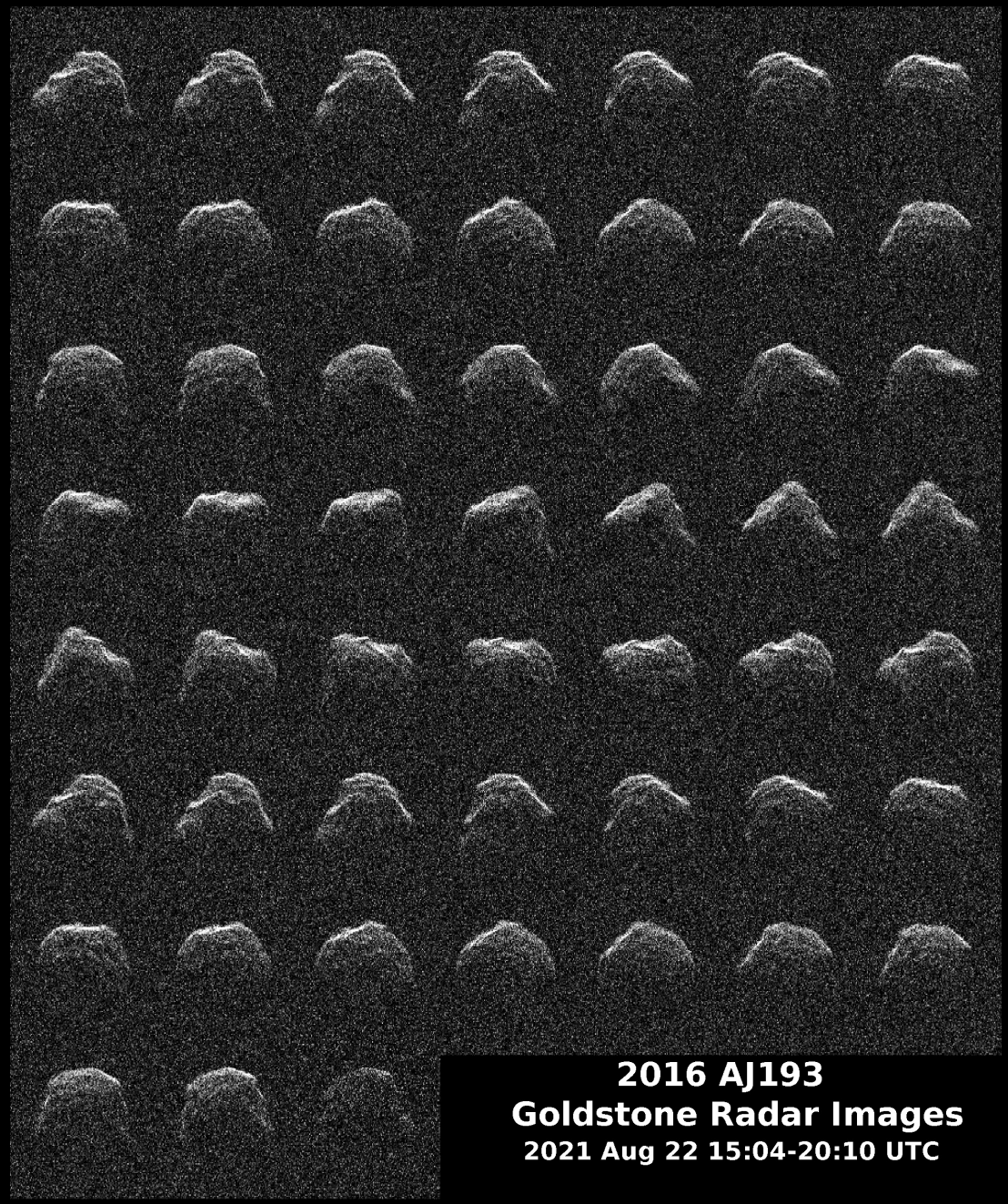
Canberra has observed six NEAs in 2021 to date. Two more are scheduled.

EISCAT 3D (Norway): radar operations begin in 2023. Plans to observe very close NEAs (most < 50 m in diameter). Sensitivity about 1/600 that of Goldstone, so dozens of NEAs are potentially detectable annually.

Green Bank Telescope: Design for a new radar; seeking funding. Cost: tens of millions.

Arecibo: Engineering design for Arecibo 2.0: seeking funding. Cost: hundreds of millions.

Recent Radar Highlight: 2016 AJ193



Close approach: 0.023 au

Diameter ~ 1.3 km
Consistent with the estimate from the WISE mission.

Optical albedo ~0.03
Cometary orbit; possible inactive comet nucleus.

Rotation period = 3.5 h

Irregular, angular shape.
Ridges, concavities, flat regions, possible boulders.

Key Recent Findings

99942 APOPHIS STUDY TEAM

SBAG encourages NASA to use resources at its disposal to identify the key science that can be addressed from the 2029 Earth flyby of asteroid Apophis and to also investigate spacecraft and ground-based opportunities to support this event. During the 2029 Earth flyby, Apophis will be a target of opportunity for both planetary science and planetary defense. The recent Apophis T-9 Years Workshop demonstrated the great community interest in this once-per-thousand-year event, and identified the encounter physics as a major area of interest for both the scientific and hazardous asteroid mitigation communities. The SBAG community concludes that the next steps in preparation for this event are focusing activity into a formal Science Definition Team or similar entity, as well as investigating how existing spacecraft and ground-based assets could enhance the science return from this event.

(Full text at https://www.lpi.usra.edu/sbag/findings/)

Update

99942 APOPHIS SPECIFIC ACTION TEAM (SAT)

Statement of Task:

The Specific Action Team (SAT) shall conduct a study to:

1. Identify and quantify the detectable effects on Apophis expected to result from the Earth encounter, and identify the measurements and instrumental sensitivities needed to detect them and determine their magnitudes;

2. Assess and prioritize the importance to planetary science and planetary defense of detecting and measuring each of these effects, as well as the value of non-detections (upper limits);

3. Categorize these effects according to (a) detectable using Earth-based assets, (b) detectable using a spacecraft arriving only after Earth close approach, (c) detectable using a spacecraft arriving before Earth close approach; and

4. Quantitatively assess the possibility that spacecraft sent to Apophis could increase the risk of a future Earth impact.

The study shall not:

Assess, prioritize, or recommend specific instruments, facilities, flight hardware, mission profiles or concepts;

Status:

Jesse Dotson (NASA) Chair; confirmed members: Tim Titus, Stephanie Jarmak, Andy Rivkin, Marina Brozovic, Steve Chesley Damya Souami

Summary

1. SBAG appreciates the support from the PAC and NASA on the support for the 99942 APOPHIS SPECIFIC ACTION TEAM (SAT). We are well on our way to forming the team and going forward.

2. SBAG continues to recommend that NASA support additional asteroid radar observations at other facilities in order to meet a portion of the scientific and planetary defense goals previously accomplished by the Arecibo Observatory

BACKUP SLIDES

Table 1. SBAG's suggested improvements to current radar capabilities. **(From the White Paper)**

Facility	Description	Estimated additional cost to NASA	Comments
DSN: Goldstone	Increased radar observing time with GSSR and DSS-13	Operating costs	
Green Bank Phase 1 transmitter Phase 2 proposal	NEO observations Development of new transmitter	Operating costs $30 million +	Collaborate with NSF
DSN: Canberra Receive with Parkes (Australia)	DSS-43 80 kW klystron New Parkes receiver	Operating costs ~$300,000	Collaborate with CSIRO
Haystack	NEO observations with existing transmitters and receivers	Operating and startup costs	Operated by MIT, Lincoln Laboratory; requires proposal to NASA.
DSN: Madrid Receive with Sardinia (Italy)	DSS-63 or DSS-53 transmitters	Operating costs	Collaborate with INAF
EISCAT UHF EISCAT 3D (Scandinavia)	Available through 2025. Buildup of new system; available after 2022.		Encourage planetary radar observations by EISCAT consortium
TIRA (Germany)	NEO observations with existing transmitter and receivers.		Encourage planetary radar observations by Fraunhofer Institute, ESA.

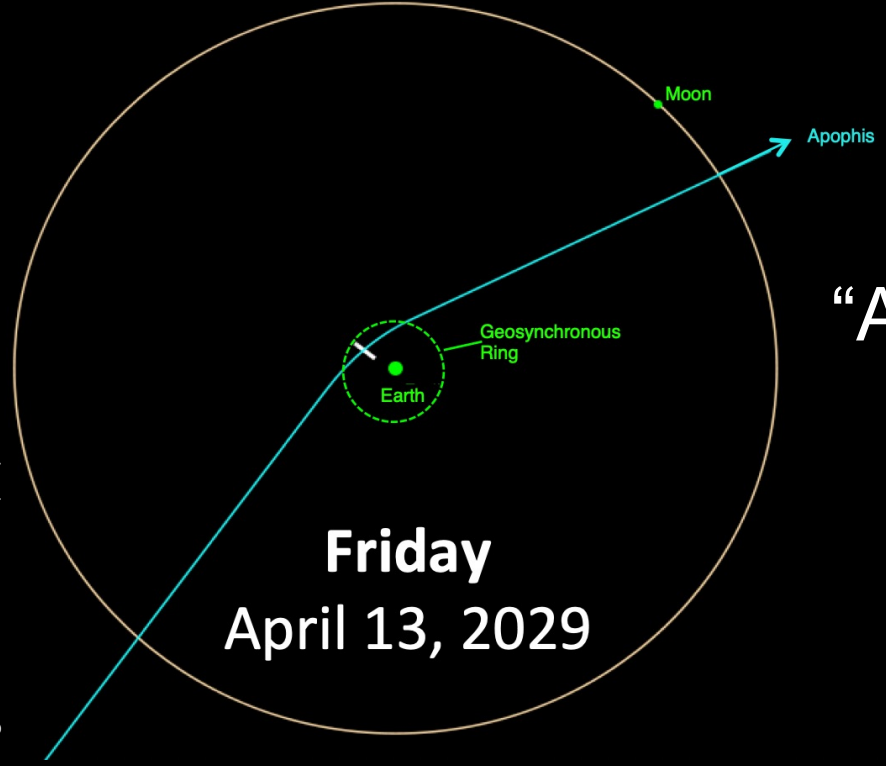


Figure credit: P. Chodas (JPL)

Apophis 2029

340m asteroid passing within 5.8 Earth-radii.

"A once-per-thousand year natural experiment."

- 300 X More massive than Tunguska body.
- 5000 X More massive than Chelyabinsk body.

Knowledge opportunity for the science of planetary defense.

Key Science Questions / Uncertainties:

- *Will tidal stresses by Earth induce any measurable effects?*
  -Seismic shaking? -Surface landslides? -Shape reconfiguring?
- *Can measurements of effects produce significant scientific advances in our understanding of the surface and interior structure of Potentially Hazardous Asteroids ?*
- *How would measurements be implemented ?*