So, how much did the Planetary Society's light sail really sail?

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- This image was taken during the LightSail 2 sail deployment sequence on July 23, 2019 at 18:49 UTC. The sail is almost fully deployed here and appears warped near the edges due to the spacecraft's 185-degree fisheye camera lens.
- This image was taken during the LightSail 2 sail deployment sequence on July 23, 2019 at 18:48 UTC. Baja California and Mexico are visible in the background.
  The Planetary Society
- These images show the progression of LightSail 2's solar sail deployment sequence, which began on July 23, 2019 at 18:47 UTC.
  The Planetary Society
- This chart shows LightSail 2's orbit apogee and perigee since launch. From July 26 to July 30, the spacecraft raised its orbital high point, or apogee, by about 2 kilometers.
  The Planetary Society
- The Planetary Society's LightSail 2 team on console prior to sail deployment at the Cal Poly CubeSat lab in San Luis Obispo, California. From left: Barbara Plante,

founder and president, Boreal Space; Alex Diaz, avionics engineer, Ecliptic Enterprises Corporation; John Bellardo, associate professor, Cal Poly San Luis Obispo; Dave Spencer, LightSail project manager, associate professor at Purdue University; Bruce Betts, LightSail program manager, Planetary Society chief scientist.
The Planetary Society

- This image labels the position of The Planetary Society's LightSail 2 spacecraft inside Prox-1, secured inside the Falcon Heavy payload fairing.
  The Planetary Society
- Schematic showing the Light Sail 2 spacecraft design.
  The Planetary Society
- And here are the dimensions of the sail.
  The Planetary Society
- This image shows several of the 24 spacecraft launching on the Air Force's STP-2 mission, which will also carry LightSail 2 to orbit. LightSail 2 and its carrier spacecraft, Prox-1, are not visible in this image.
- A SpaceX Falcon Heavy rocket carrying 24 satellites as part of the Department of Defense's Space Test Program-2 (STP-2) mission launches from Launch Complex 39A, Tuesday, June 25, 2019 at NASA's Kennedy Space Center in Florida.

For the last four decades, the Planetary Society has admirably sought to bring the people interested in space a little closer to the action, to give them a voice in space policy, and to advocate for more public spending on exploration. And the organization has also sought to become a part of the action—by flying its own missions. Now, it appears to have done just that.

On Wednesday, the organization co-founded by Carl Sagan in 1980 declared "mission success" for a small spacecraft launched on June 25 by a Falcon Heavy rocket, saying its small solar sail had raised the apogee of its orbit around Earth by

1.7km over the course of four days. “We completed its primary goal of demonstrating flight by light for CubeSats,” said Bruce Betts, the LightSail 2 program manager and chief scientist at The Planetary Society.

A solar sail is a material in space with a bright, mirror like surface. When photons from the Sun hit the sail they do not have mass, but they do have momentum, which then transfers to the sail. If the sail is oriented properly, the continued bombardment by photons can move the sail. By changing the angle of the sail relative to the Sun, a solar sail can theoretically raise its orbit, and this was the test the Planetary Society set for itself with the LightSail 2 mission.

To sail, or not to sail?

However, after the announcement, several scientists began to question the achievement by LightSail 2 on Twitter and in email. For example, Harvard University astrophysicist Jonathan McDowell wrote, “I am not seeing the claimed orbit raising in the data. I see the normal orbit decay, but an increase in eccentricity presumably caused by the sail—so yes apogee is going up, but perigee is going down even faster.”

And in response to a query from Ars about whether this achievement constituted solar sailing, an expert in the field, Tomas Svitek, replied, “If ‘sailing’ means controlled orbit raising, then no. LS-2 orbit is modified by solar radiation pressure, that is not new. But orbit energy has not been increasing. Likely explanation is that spacecraft is randomly tumbling, not actively changing its attitude around orbit.”

Essentially, then, the question is whether the “solar sailing” done by the Planetary Society’s mission is a significant enough effect to offset the atmospheric drag and general solar radiation pressure effects that would tend to drag it back downward toward Earth. In short, are they really able to control the spacecraft in its orbit around Earth?

Controlled sailing

Asked about this on Thursday, LightSail 2 Project Manager David Spencer told Ars that engineers have indeed been actively controlling the attitude of the spacecraft about two-thirds of the time.

“About one-third of the time, we have been in ‘detumble’ mode, reducing the momentum wheel speed and allowing our torque rods to remove angular momentum from the system,” Spencer acknowledged. “When in detumble mode we are not actively controlling the orientation of the sail relative to the Sun.”

- Graphic showing simulated spacecraft tumbling versus LightSail 2’s actual flight.
  The Planetary Society
- This plot shows the sail orientation history for several orbits during July 28.
  The Planetary Society

Also on Thursday, a doctoral student at Purdue University working on the project, Justin Mansell, simulated a tumbling spacecraft using the initial orbit conditions right after sail deployment versus the “controlled” sailing by the LightSail 2 spacecraft. The organization shared the results with Ars, which are shown above. They do appear to demonstrate controlled flight.

A second graphic demonstrates sail control performance and coterminous flight data. “We also put together a plot showing the sail orientation history for several orbits during July 28,” Spencer said. “This was the day that we raised apogee by more than 900 meters. This clearly shows that the spacecraft is actively controlling toward the desired attitude, and it’s generally consistent with the expected performance based upon simulations.”

To be fair, the Planetary Society has never claimed LightSail

2 to be more than a budget-conscious “demonstration” mission, seeking only to provide flight data that can feed forward to help future solar sailing missions. Funded by donations from 50,000 members, the mission had a total budget of only about $7 million. From these efforts, the organization hopes to inspire future planetary missions to use solar sailing as a low cost, fuel-free means of propulsion around the Solar System.

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