2020 BX12: THE LAST BINARY ASTEROID DISCOVERED BY ARECIBO OBSERVATORY

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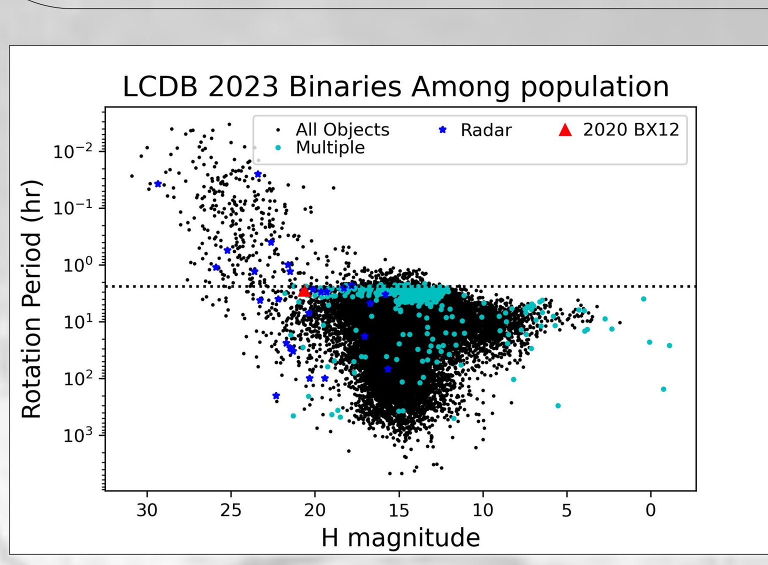
Asteroid 2020BX12 is a binary system consisting of two bodies that are orbiting a common center of mass. It was discovered on January 27, 2020, by the Asteroid Terrestrial-impact Last Alert System (ATLAS) survey at the Mauna Loa Observatory. The object was found to be a potentially hazardous asteroid (PHA) due to its expected diameter of over 200 m (H=20.6) and its close approach on February 3 2020 at 0.029 au. Radar observations of the asteroid were carried out with the S-band planetary radar system (2380 MHz, 12.6 cm) at the Arecibo Observatory on February 4 and 5, 2020.

- The S-band system at AO can transmit and receive circularly polarized waves, both same-sense circular (SC) and opposite-sense circular polarization (OC).
- Radar observations begin with a continuous-wave measurement to obtain the Doppler frequency spectrum of the echo.
- The measured Doppler spectrum bandwidth provides initial limits for the rotation period and the object's apparent diameter.
- Phase modulation is used for targets with high SNR to produce delay-Doppler images, which have fine range resolution.
- Delay-Doppler images aid in estimating the object's diameter, rotation rate, and shape

- PHA: Yes
- Discovery: 2020 Jan 27
- H (D): 20.8 (200+ 200 m)
- MOID: 0.0021 au (<1 LD)
- Family: Apollo-group
- Close approach: 2020 Feb 03
- Close approach distance: 11.4 LD (0.0292 au).
- Telescope: Asteroid Terrestrial-impact Last Alert System (ATLAS) survey at Mauna Loa Observatory.



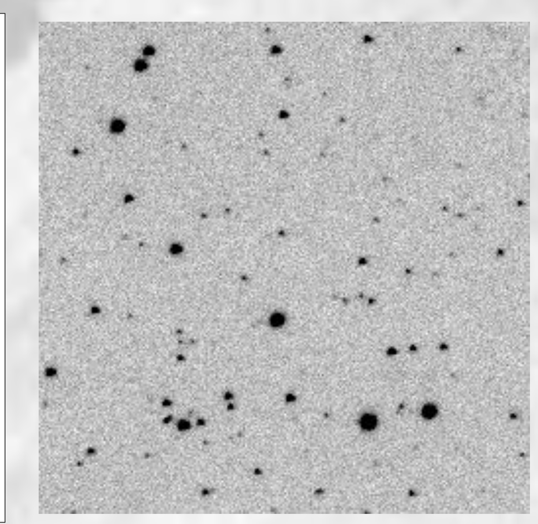
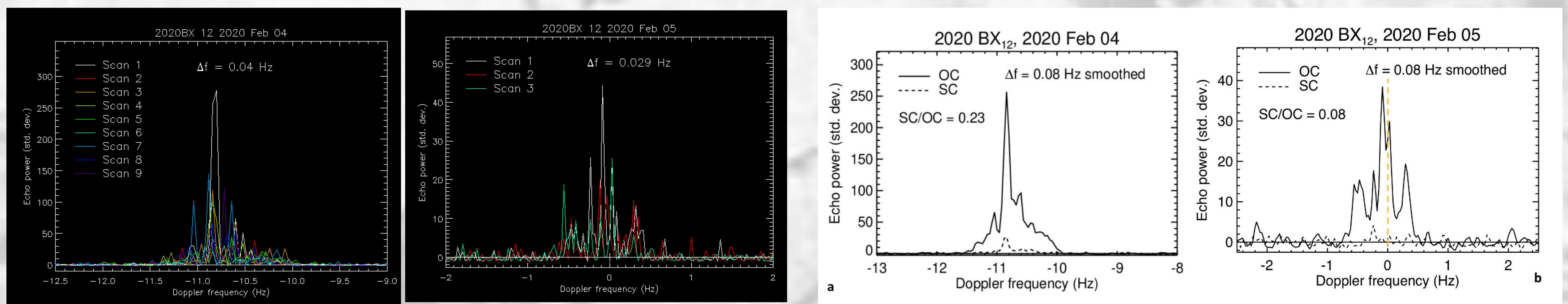
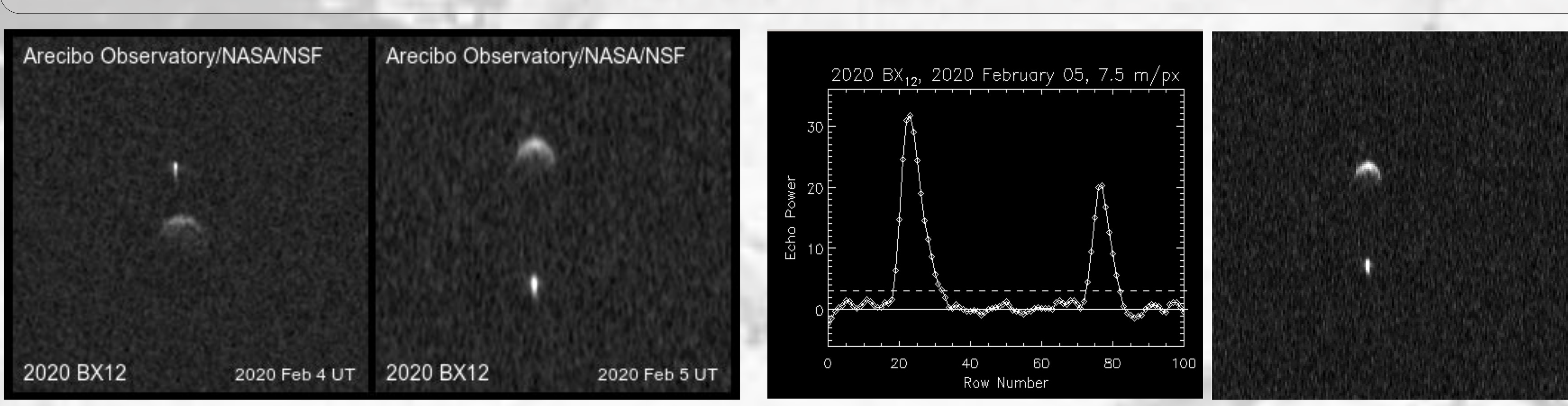


Image from: AiM project group at Cerro Tololo-LCO A/Chile about 17 hrs post discovery.



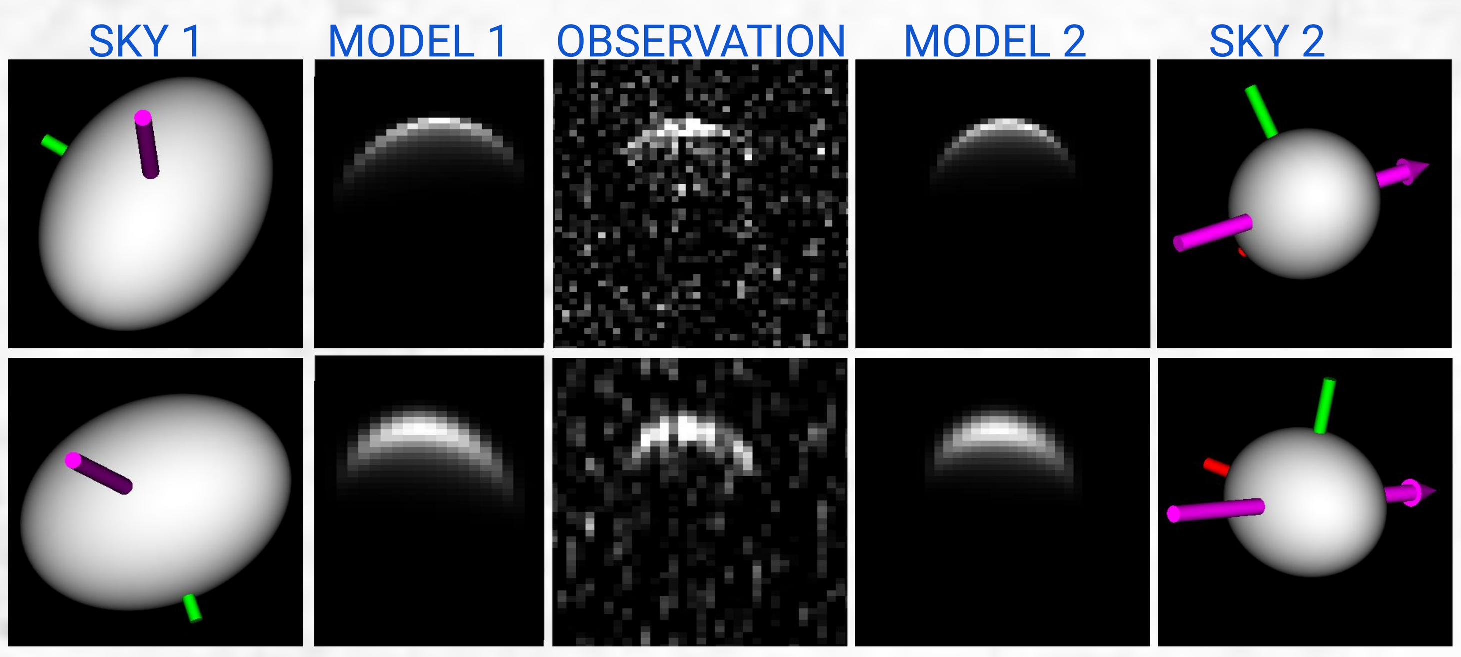
Continuous wave echo power spectra of both days of observation. Left panel, all scans of each day of observation, overplotted. Right panel (a) Sum of all scans for Feb 04. Secondary is clearly visible as a superposed signal of the primary. (b) Sum of all scans for Feb 05 observations, where the secondary is visible, but the data set is noisier.

Based on radar observations, from the measured bandwidths, the rotation period of the primary is estimated to be P_{rot}= 2.5±1 hr and of P_{rot}=25 ±5 hr for the secondary.
The primary component of the binary system was estimated to have a diameter of about 270 ± 90 m, while the secondary component was roughly half the size of the primary.
The maximum separation observed between the two bodies was roughly 360 m.
The sub-radar latitude at the time of observation was estimated to be between 30 and 40 degrees, if the spin axis is aligned with the heliocentric orbit normal.
Additionally, radar images taken 24 hours apart showed a mutual-orbital phase change of about 180 degrees, which suggests a mutual-orbit period of 45-50 hours. However, a shorter orbital period of 15-16 hours has not been ruled out.



Delay-Doppler images of NEA/PHA 2020 BX12 for both days of observation. Figure on the left displays the to data acquired at phase modulation of 0.05 microseconds, which corresponds to a resolution of 7.5 meters per pixel in delay and 0.075 Hz per pixel in Doppler at 1 sample per baud. Image on the right has a phase modulation of 0.2 microseconds, corresponding to a resolution of 7.5 meters per pixel in delay and 0.075 Hz per pixel in Doppler; at 4 samples per baud.

Closeup of secondary. Shape is clearly not resolved. Object extends a few pixels, for a diameter of about 70 ± 30 m.



←The panels display two ellipsoid models with dimensions and rotation periods. The first is on the left (sky 1) with a pole at (10, +10), while the second is on the right with a pole at (334, +40). Both data and synthetic-echo images show a downward delay and a rightward frequency increase. The plane-of-sky images have celestial north at the top and colored rods indicate the principal axes of inertia, with red for minimum inertia and green for intermediate axis. The purple arrow denotes the rotation vector aligned with the axis of maximum inertia.

Importance of Arecibo Observatory for Planetary Defense:
The Arecibo Observatory played a significant role in planetary defense by providing a unique capability for detecting and characterizing near-Earth objects (NEOs, PHAs), Planets, and even spacecraft support. The observatory's planetary radar system was a critical tool for studying NEOs and understanding their physical properties, including size, shape, rotation, and surface properties. It was one of only a few facilities in the world capable of conducting high-resolution radar

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