JWST Observations of Potential Impactor 2024 YR4 (March 27, 2025)

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Summary: JWST obtained measurements of 2024 YR4 on 26 March 2025. Modeling of the spectral energy distribution indicates an estimated diameter of 60 ± 7 m.

Background: The damage potential of an impacting asteroid is primarily informed by knowledge of its size. Asteroid 2024 YR4 – whose impact probability with Earth in 2032 reached 3.1% before dropping to nearly 0% – lacked precise size measurements and thus corresponding damage potential. We do not have any imagery of 2024 YR4 showing it as more than a point of light. From previous ground-based visible light measurements, we can infer a size range of 40-90 meters. However, by measuring its brightness across a range of infrared wavelengths, we can better determine its size range. Owing to its infrared capabilities, the Mid-Infrared Instrument (MIRI) on JWST is uniquely suited for such a more precise assessment, esp. for decameter objects. [1]

On 29 January 2025, our international team of scientists proposed a program of observations to JWST, which was accepted on 5 February. 2024 YR4 entered JWST's observation window on 8 March, and observations were made 5:15:16 – 10:52:09 UT on 26 March 2025 UT.

Analysis: The exposure times were set to match the rotation period of 2024 YR4 of 19.5 minutes [2], each exposure averaging over the entire object. After applying standard MIRI processing [3-4], team members used models [5] to fit the brightnesses of 2024 YR4 in mid-infrared wavelengths, taking the known distances and angles between the asteroid, the Sun, and JWST as inputs.

Results: Initial independent analysis from the international team members yield a consensus size of 60 ± 7 m, corresponding to a 92% probability that 2024 YR4 is larger than 50 m in effective diameter, which is the threshold size for the Space Mission Planning Advisory Group (SMPAG) to become active [6]. The consensus solutions show a cooler surface than typical for asteroids at 2024 YR4's size and solar distance, perhaps suggesting a rockier surface than commonly inferred [7].

Next Steps: Additional observations of 2024 YR4 will be made by JWST in May 2025, which will primarily help refine the orbital and thermal properties of 2024 YR4. While an Earth impact by 2024 YR4 on December 22, 2032 has now been ruled out, it continues to have a non-zero probability of impacting the Moon at this time. The work described here will be submitted for peer review and publication in the scientific literature.

References:

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