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Reconnaissance Missions to Near-Earth Object Impact Threats: A Pragmatic Approach

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If an asteroid or comet is found on a potential Earth-impact trajectory, a top priority should be to reduce uncertainties in whether the object will impact the Earth and in the potential consequences of the possible impact. Ground- and space-based telescopes will provide essential data for reducing some uncertainties. A reconnaissance spacecraft mission, however, can provide key information that cannot be obtained through other methods. Such information can slash uncertainties about the possible impact, thereby improving planning for both consequence management and space missions to prevent Earth impact.

The value of spacecraft reconnaissance missions is well established [1,2,3] and documented in relevant reports from the U.N.-endorsed Space Mission Planning Advisory Group (SMPAG) [2] and in the United States' *Report on Near-Earth Object Impact Threat Emergency Protocols (NITEP)* [3]. Both SMPAG and NITEP recommend that planning of space mission options begin once there is a >1%

probability that an object characterized to be greater than 50 m in size will impact within 50 years [2,3].

Beyond that, the U.S. NITEP and SMPAG recommendations diverge. SMPAG does not recommend thresholds for implementing (as opposed to planning) mission options. The NITEP, in contrast, states that if the previously mentioned thresholds for mission options planning are met, then "if time before impact permits–the United States should proceed quickly with a reconnaissance mission, in cooperation with international partners if possible." [3] NITEP briefly discusses the cost/benefit analysis of reconnaissance missions [3], but lacks recommendations about the particulars of implementing a reconnaissance mission. Specifying recommendations will streamline discussions about courses of action in the event of an actual impact threat, thereby saving time in a potentially time-sensitive situation.

We propose that the organizations who provide guidance about planetary defense mission options adopt the following pragmatic recommendation for reconnaissance missions: When the SMPAG thresholds for mission option planning are crossed and when warning time is sufficient, one or more space agencies should implement whatever type of reconnaissance mission will provide actionable information the soonest. This time-sensitive information is critical to have in hand to inform consequence management and, if needed, Earth impact prevention missions. Both purpose-built and repurposed spacecraft missions (e.g., redirecting an existing spacecraft) should be considered. If a suitable spacecraft can rendezvous with the threat object sooner than a flyby mission can reach it, then a rendezvous mission is preferable due to its higher characterization fidelity. A yearning for better data should not delay the timely collection of actionable data.

[1] NASEM. 2023. *Origins, Worlds, and Life: A Decadal Strategy for Planetary Science and Astrobiology 2023-2032*. Washington, DC: The National Academies Press. https://doi.org/10.17226/26522.

[2] Recommended criteria & thresholds for action for a potential NEO impact threat, SMPAG-RP-003/1.0, 2018 Oct 18. https://www.cosmos.esa.int/documents/336356/1879207/SMPAG-RP-003_01_0_Thresholds%26Criterion_2018-10-18.pdf/58eb84ae-e3b6-1b08-9465-d25c548c5c9b

[3] NSTC, 2021, Report on Near-Earth Object Impact Threat Emergency Protocols. 39 pages. https://trumpwhitehouse.archives.gov/wp-content/uploads/2021/01/NEO-Impact-Threat-Protocols-Jan2021.pdf

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Comments: I'm open to either oral or poster. This could fit in either the Decision to Act or Space Missions sessions.