

## IAF COMMITTEE ON PLANETARY DEFENSE (PD) AND NEAR-EARTH OBJECTS (NEOs)

### Introduction

Planetary defense refers to the array of scientific, technical, and institutional capabilities required to detect, characterize, and monitor asteroids and comets that may pose a potential impact threat to Earth, and to develop and implement measures aimed at preventing or mitigating their possible consequences. A Near-Earth Object (NEO) is defined as an asteroid or comet whose orbital path brings it within approximately 45 million kilometers of Earth's orbit. The IAF Technical Committee (TC) on Planetary Defense and Near-Earth Objects seeks to advance global understanding and awareness within the space community by fostering dialogue, collaboration, and outreach across disciplines. Its principal mission is to promote planetary defense initiatives, particularly among participants of the International Astronautical Congress (IAC), and to encourage and support greater engagement from the next generation of researchers, students, and young professionals in the field.

### Summary

The past year 2024-2025 included several key developments in planetary defense. On 1 August 2024, the Space Mission Planning Advisory Group (SMPAG) initiated a hypothetical Near-Earth Asteroid impact exercise "2024PDC25", conducted in connection with the Planetary Defense Conference (PDC) 2025 scenario. The exercise involved coordinated participation from SMPAG members and generated broad discussion within the community.

In October 2024, ESA's Hera mission was launched toward the Didymos-Dimorphos system to obtain post-impact observations following NASA's 2022 DART mission.

In December 2024, the discovery of asteroid 2024 YR4 led to short-term concern when early orbital calculations indicated a Level 3 on the Torino Scale. Subsequent international follow-up observations refined the orbit and confirmed that no impact threat existed. That same month a resolution was

adopted by the United Nations designating the year 2029 as the "International Year for Asteroid Awareness and Planetary Defence 2029 (IYAPD2029)".

In January 2025, ESA's RAMSES mission concept completed its Preliminary Design Review, advancing plans for a rapid-response probe to rendezvous with Apophis before its 2029 close approach.

In April 2025, international researchers met in Tokyo for joint workshops on Hera, RAMSES, and Apophis T-4 to coordinate planning activities. In May, the ninth IAA Planetary Defense Conference took place in South Africa, featuring a new hypothetical impact scenario for testing response procedures. By July 2025, SMPAG established an ad hoc working group on Apophis to be coordinated by COSPAR. In September, NASA's OSIRIS-APEX mission completed its Earth gravity-assist maneuver en route to Apophis, and ESA and JAXA presented their collaboration on the RAMSES mission at the IAC. During the same period, the Rubin Observatory reported its first series of asteroid detections.

These activities collectively reflect the continuation of coordinated international efforts to strengthen detection, response planning, and mission development related to near-Earth objects and to the growing field of planetary defense.

### Highlights

Over the past year, notable developments in near-Earth object research and planetary defense included the detection of a potential Earth impactor that activated international notification protocols before being ruled out as a threat, the first use of the James Webb Space Telescope (JWST) to observe a potential impactor, a key mission milestone in ESA's Hera mission to the Didymos system, and the expansion of NEO observation capabilities at the Purple Mountain Observatory.

On 27 December, 2024, the ATLAS sky survey discovered a previously unknown asteroid designated 2024 YR4. As

additional telescopic data accumulated, the probability that 2024 YR4 would impact Earth increased and reached 1% for 2032. Given that the threshold proposed by the International Asteroid Warning Network (IAWN, iawn.net) for issuing warnings of possible impact effects is a probability of impact greater than 1% and a rough size estimated to be greater than 10 meters, on 29 January 2025, IAWN issued a notification to the United Nations Office of Outer Space Affairs about a potential asteroid impact on Earth on 22 December 2032. Observations of 2024 YR4 continued, and on 24 February 2025, IAWN issued a notification stating that Earth impact had been ruled out. This asteroid, 2024 YR4, marked the first time that IAWN issued a notification about a real potential Earth impactor, as opposed to a hypothetical one. Many lessons were learned as a result of this real-world event. As of this writing, there is still a ~4% probability that YR4 will impact the Moon in 2032. The asteroid will become observable again in 2028.

When asteroid 2024 YR4 was first discovered, little was known about its physical characteristics. Initial estimates placed its size between 40 and 90 meters, resulting in substantial uncertainties regarding the potential effects in the event of an Earth impact. Recognizing the need for better information about the asteroid's size, a team led by Andy Rivkin of the Johns Hopkins University Applied Physics Laboratory proposed to observe 2024 YR4 with the James Webb Space Telescope. That proposal was selected, and JWST observed 2024 YR4 on 26 March 2025. Analysis of the JWST data revealed the asteroid to be  $60 \pm 7$  m in size, thereby markedly improving knowledge of this key asteroid property. Information from JWST about the position of 2024 YR4 in the sky also refined the asteroid's orbit.

In March, ESA's Hera spacecraft flew past Mars en route to rendezvous with the binary Didymos asteroid system and investigate the aftermath of NASA's Double Asteroid Redirection Test (DART) mission. The flyby went smoothly, and instruments on the spacecraft collected data of the Mars system, including its second moon Deimos, during the encounter. Critically, the mission successfully tested the natural feature tracking software onboard the spacecraft, which will enable autonomous navigation at Didymos.

Finally, the Purple Mountain Observatory in China is expanding its NEO observation network with new facilities, leading to the discovery of 70 new near-Earth asteroids and enabling routine monitoring and physical characterization of hundreds of NEOs annually.

## Outlook

As part of the world's first test of asteroid deflection, ESA's Hera spacecraft will rendezvous with the asteroid 65803 Didymos in November 2026 to conduct over 6 months a detailed post-

impact survey of the target Dimorphos (the orbiting moonlet of Didymos binary asteroid system). In September 2022, NASA's Double Asteroid Redirection Test (DART) successfully impacted Dimorphos at a high speed of ~6.6 km/s.

JAXA's Hayabusa2# spacecraft will perform a high-velocity flyby of asteroid 98943 Torifune in July of 2026, prior to its scheduled rendezvous with the small (~11 m diameter), fast-rotating asteroid (~5.35 minutes) 1998 KY26 in 2031. Hayabusa2# is extension of the Hayabusa2 mission that was launched in 2014, successfully rendezvoused with near-Earth asteroid 162173 Ryugu in June 2018 and returned samples to Earth in December 2020.

The Vera C. Rubin Observatory, formerly the Large Synoptic Survey Telescope (LSST), saw first light in June. This astronomical observatory, located in the Coquimbo Region of Chile, will scan the southern sky, capturing a new 3,200-megapixel image every 40 seconds. Every three nights, the telescope will revisit the same region of the sky, constructing a time lapse of the cosmos that will unfold over a decade. Rubin has multiple scientific objectives, but this "data deluge" is expected to increase the number of cataloged near-Earth objects by a factor of 10-100.

NASA's Near-Earth Object (NEO) Surveyor, a space-based infrared telescope with a 0.5 meter, is planned to launch in late 2027. NEO Surveyor will be the first space telescope specifically designed to detect asteroids and comets that may pose a potential hazard to Earth. Its primary objective is to meet the U.S. Congressional mandate to discover 90% of the estimated 25,000 potentially hazardous asteroids, objects larger than 140 meters that pass within approximately 20 lunar distances of Earth's orbit, within ten years. In addition to detection, NEO Surveyor will characterize these objects, provide data to support planetary defense missions, and lay the foundation for future survey efforts.

The year 2029 will be an exciting one for planetary defense. That year has been designated as the International Year of Asteroid Awareness and Planetary Defense by the United Nations, with the aim of promoting public awareness of asteroid impact hazards and the global coordination and communication measures that would be implemented in the event of a credible Earth-impact threat. That year's highlight will occur 13 April 2029, when asteroid 99942 Apophis will make an exceptionally close, but safe, approach to Earth, passing at a distance of approximately 32,000 kilometers above the surface. Apophis will be visible to the naked eye in some regions of the world. This close approach offers a unique scientific opportunity to characterize Apophis and to study the gravitational effects associated with an asteroid passing in such proximity to Earth.

## Committee activities

For 2025-2026, the IAF Technical on Planetary Defense and Near-Earth Objects plans to launch several new initiatives. A Special Session proposal is being prepared for IAC 2026 in Antalya, Türkiye, with the goal of engaging students and early-career professionals through an interactive activity. Future initiatives are also expected to be coordinated with the International Astronautical Federation (IAF) Small Bodies Technical Committee to build sustained momentum toward the 2029 Apophis Earth's flyby and to establish a multi-

year framework. The Committee also plans to undertake coordinated efforts in collaboration with SMPAG and with the International Year of Asteroid Awareness and Planetary Defense team. In parallel, the committee will continue to support community gatherings and technical exchanges among planetary defense experts, including those organized during the 2025 UK NEO Community Days, the Apophis T-X years workshops, the planetary defense sessions of various international congresses (EPSC, DPS, JpGU, AGU) and the Planetary Defense Conference 2027.