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The Age of Planetary Defense

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Abstract

NASA and its partners maintain a watch for near-Earth objects (NEOs), asteroids and comets that pass within Earth's vicinity, as part of an ongoing effort to discover, catalog, and characterize these bodies and to determine if any pose an impact threat. NASA's Planetary Defense Coordination Office (PDCO) is responsible for:

- Ensuring the early detection of potentially hazardous objects (PHOs) – asteroids and comets whose orbits are predicted to bring them within 0.05 astronomical units of Earth's orbit; and of a size large enough to reach Earth's surface – that is, greater than perhaps 30 to 50 meters;
- Tracking and characterizing PHOs and issuing warnings about potential impacts;
- Providing timely and accurate communications about PHOs; and
- Performing as a lead coordination node in U.S. Government planning for response to an actual impact threat.

The PDCO collaborates with other U.S. Government agencies, other national and international agencies, and astronomers around the world. The PDCO also is responsible for facilitating communications between the science community and the public should any potentially hazardous NEO be discovered. In addition, the PDCO works closely with the United Nations Office of Outer Space Affairs, its Committee on the Peaceful Uses of Outer Space, and its Action Team on Near Earth Objects. The PDCO is a leading member of the International Asteroid Warning Network (IAWN) and the Space Missions Planning Advisory Group (SMPAG), multinational endeavors endorsed by the United Nations for an international response to the NEO impact hazard and established and operated by the space capable nations. In this paper, we will provide an overview of the office's various planetary defense efforts.

1. Introduction

Near-Earth objects are asteroids and comets whose orbits periodically bring them within 1.3 Astronomical Units (AU) of the Sun. This implies that they can come within ~0.3 AU – about 30 million miles, or 50 million kilometers – of Earth's orbit. A subset of NEOs includes potentially hazardous object (PHOs), which pass within 0.05 AU of Earth's orbit.

Dust, meteoroids, and small asteroids impact Earth regularly, but larger objects have both the potential for considerable damage yet also the potential for discovery with enough lead time to formulate a response. Responding to a potential asteroid impact to Earth will require expertise and resources from across federal governments across the world. A strategy to both integrate existing assets and add important capabilities in an effort to improve our collective preparedness is of critical value and the reason behind the creation of the NASA's Planetary Defense Coordination Office (PDCO) [1]. Planetary defense is the term used to encompass all the capabilities needed to detect and warn of potential asteroid or comet impacts with Earth, and then either prevent them or mitigate their possible effects. The first step of planetary defense involves finding and tracking near-Earth objects regarding observational assets and statistics. Finally, we will go over the interagency and international planetary defense coordination strategy with information on how to join.

2. Near-Earth Object Observations Program

The NEO Observations Program sponsors applied research conducted by NASA, other federal agencies, universities, space science institutes, and other organizations around the United States. The NEO Observations Program supports astronomical surveys for NEOs that contribute to a sustained and productive campaign to find and track NEOs, collecting data of sufficient precision to allow accurate predictions of the future trajectories of

discovered objects. The Program also supports efforts to characterize a representative sample of NEOs by measuring their sizes, shapes, and compositions. In addition, the Program devotes a limited amount of funding to research into NEO characteristics that relate to development of impact mitigation and deflection strategies and techniques.

NASA-funded survey projects have found about 98 percent of the known catalogue of close to 17,000 NEOs as of October 2017. NASA-funded surveys are currently finding NEOs at a rate of about 1,800 per year. The current congressionally directed objective of the NEO Observations Program is to find, track, and catalogue at least 90 percent of the estimated population of NEOs that are equal to or greater than 140 meters in size by 2020 and to characterize a subset of those objects that is representative of the entire population. Roughly half of the known catalogue of NEOs are objects larger than 140 meters in size. The predicted population of NEOs of this size is about 25,000. Current surveys are finding NEOs of this size at a rate of about 500 per year, and roughly two thirds of the population remain to be discovered after almost 20 years of NEO search efforts.

NEO surveys currently supported by the NEOO Program include the University of Hawaii's Panoramic Survey Telescope & Rapid Response System (Pan-STARRS), the University of Arizona's Catalina Sky Survey, the Lincoln Near-Earth Asteroid Research (LINEAR) project on the Space Surveillance Telescope, and the NEO Wide Infrared Survey Explorer (NEOWISE) mission. The NEO-optimized infrared survey mission concept NEOCam is currently in extended Phase A study as a planetary defense focused mission. NEO follow-up and physical characterization efforts are supported at a number of NASA Centers, observatories, universities, and institutes.

All NEO search and tracking projects supported by the Program are required to make their astrometric data permanently available in a timely manner to the scientific community. The internationally recognized public archive for these data is the Minor Planet Center [4], which is sanctioned by the International Astronomical Union and supported by the NEO Observations Program as a sub-node of NASA's Planetary Data System's Small Bodies Node [5]. The Minor Planet Center is also tasked with notifying observers worldwide about new discoveries so they can conduct timely follow-up observations critical for confirmation and future orbit determination.

The NEO Observations Program also supports the Center for NEO Studies (CNEOS) [2] at the Jet Propulsion Laboratory which maintains up-to-date data and statistics on NEO discoveries. CNEOS also uses the collected observations to compute high-precision orbits of NEOs, model new orbits for NEO discoveries to determine impact hazard, perform long-term analyses of future orbits of potentially hazardous asteroids, and calculate the impact time, location and other parameters in the event of a predicted impact.

3. International Cooridnation

The PDCO has also worked closely with the United Nations Office of Outer Space Affairs and the Committee on the Peaceful Uses of Outer Space, through its Action Team on Near Earth Objects (also known as Action Team 14). The International Asteroid Warning Network (IAWN) [3] and the Space Missions Planning Advisory Group (SMPAG) [6] are multinational endeavors endorsed by the United Nations for an international response to the NEO impact hazard. NASA currently chairs IAWN, whose intent is to establish a worldwide effort to detect, track, and physically characterize near-Earth objects (NEOs) to determine those that are potential impact threats to Earth and to which there are eight international signatories that include observatories, national institutes, and space agencies. NASA participates with other space-capable nations in SMPAG, whose objectives are to develop cooperative activities among its members and to build consensus on space mission recommendations for planetary defense measures. In the event of a credible impact warning by IAWN, the SMPAG would propose mitigation options and implementation plans for consideration by the international community

4. Summary and Conclusions

The PDCO's activities described here involving the NEO Observations Program and international coordination are consistent with its mission to lead national and international efforts to detect any potential for significant impact of planet Earth by natural objects, appraise the range of potential effects by any possible impact, and develop strategies to mitigate impact effects on human welfare.

References

[1] Planetary Defense Coordination Office Web site: https://www.nasa.gov/planetarydefense/overview

[2] Center for Near Earth Object Studies Web site: https://cneos.jpl.nasa.gov

[3] International Asteroid Warning Network Web site: http://iawn.net

[4] International Astronomical Union Minor Planets Center Web site: http://www.minorplanetcenter.net

[5] Planetary Data System Small Bodies Node Web site: https://pds-smallbodies.astro.umd.edu/

[6] Space Mission Planning Advisory Group Web site: https://www.cosmos.esa.int/web/smpag/home