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## **Increasing the Scope of Planetary Defense Activities: Programs, Strategies, and Relevance in a Post-COVID-19 World**

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## Summary

The value of natural disaster preparation is now, more than ever, readily apparent to the public. The rise and rapid spread of COVID-19, coupled with the upheaval of daily life, has created a new experiential familiarity with the consequences of low probability, high-impact events. Collisions with near-Earth objects (NEOs), being perhaps the ultimate “high-impact” event, have new relevance in this context.

Within the confines of the decadal survey process, the science community can incorporate lessons of the COVID-19 pandemic, specifically in how it recontextualizes planetary defense. There is now a framework by which to connect a more robust investment in planetary defense activities by appealing to the direct experience of the public and lawmakers on the importance of disaster preparation.

In addition to the societal benefits from an increased commitment to planetary defense, the scientific community would also directly benefit from an increase in ground-based observations and flight missions. A more robust program would provide information on asteroid threats, increased scientific understanding of asteroids and small bodies, and a means by which to experiment with new mission types and partnerships.

The decadal committee should endorse an ongoing planetary defense flight program—the *Defender* program—that supports directed and competitively-selected missions of opportunity. To provide additional and immediate value to NASA and the scientific community, this flight program should be granted the flexibility to partner with other agencies, NASA programs, private organizations, and academic partners to demonstrate detection, characterization, and deflection capability.

The first space-based priority of this program should be to launch the NEO Surveillance Mission (NEOSM) by the mid-2020s. After that, the close-approach of Apophis presents a rare opportunity to organize a series of small missions to advance both scientific and planetary defense capabilities, and to grow the budget and scope of the Planetary Defense program itself. There are also strong synergies between space- and ground-based detection and characterization programs and flight missions.

## Planetary Defense as Disaster Preparation

The scientific community, when considering its priorities and how to advocate for them, should not shy away from using current cultural and experiential frameworks to effectively communicate the importance of planetary defense. Though not purely

scientific in nature, by embracing the effort, the planetary science community would demonstrate broad relevance to the public and to lawmakers, which can help to further build support for the goals of the community writ large.

Humanity's collective 200,000-year history has been lived in a state of pleasant ignorance of the threat posed by NEO. Fortunately for the species, there were no impacts large enough to threaten its existence during this period, and no such objects are likely to collide with us within the coming 100 years. Humanity was lucky, in that regard. But luck is not a plan (Binzel 2019). It is difficult to muster public funds to prepare for relatively common natural disasters, much less more improbable calamities such as pandemics and NEO impacts. Rare threats can appear irrelevant to the body politic compared to more pressing issues, and the political system responds accordingly.

This political challenge diminishes when the unlikely is made manifest, and a disaster occurs (or nearly occurs). Countries that experienced recent viral health threats, such as China and other nations with SARS in 2002, rapidly deployed substantial and effective responses to COVID-19 that helped suppress the outbreak (Nkengasong 2020).

The shift in public attitude is already happening within the United States. In the first 6 months of 2020, the U.S. government spent trillions of dollars reacting to the coronavirus, with significant amounts directed towards public health, research, vaccine development, and testing infrastructure—areas previously targeted for spending cuts. Americans themselves are changing their perspectives about their own safety in the face of natural threats, with a 20% spike of individuals believing that they will experience a natural disaster in their lives as of March of 2020 (Healthcare Ready 2020).

Like future pandemics, the ability to respond effectively to a NEO impact threat will depend on advance planning and early monitoring. To put this in the current language of pandemics, this preparation must include work to understand and characterize the family of “viruses” (NEOs), to survey and monitor for “early breakouts” (detecting potentially hazardous objects years in advance), and to develop effective “treatments” (deflection techniques) in advance of any specific threat.

### **Planetary Defense Was Already a Public Expectation**

Even prior to the coronavirus, planetary defense activities had high levels of public support. Two recent polls of the American public (Pew 2018, Bloomberg 2018) ranked

planetary defense as the second most important activity NASA should pursue—far above returning humans to the Moon or sending them to Mars.

As discussed previously, it's likely that public support has only increased given the heightened awareness of disaster preparation and the consequences of the lack thereof.

Notably, the public ranked scientific research as the third-highest priority activity at NASA (Pew 2018). This suggests that the scientific community can engage with planetary defense to establish a program that would enjoy high levels of public support, benefitting from both the self-interested, humanitarian motivations for planetary defense and the desirable result of increased scientific understanding of the cosmos.

### **Despite High Public Support, Planetary Defense Receives Little Funding**

NASA's expenditures on planetary defense, though greatly improved in recent years, are meager. Prior to fiscal year (FY) 2009, the program subsisted on less than \$4 million per year and bounced around various NASA divisions from Earth Science to Human Spaceflight. Growing consensus for the program's importance (as established in NEO SDT 2003, NASA Authorization 2005; National Academies 2010, National Academies 2019) as well as the brief alignment with human spaceflight goals of visiting a near-Earth asteroid, led to modest increases in funding by the early 2010s (Dreier 2019). But it was not until the approval of the Double Asteroid Redirection Test (DART) mission in FY 2019 that the program broke \$100 million for the first time in its history (Figure 1).

The funding level now supports ground-based NEO observations and a tenuous directed mission line with a flight rate of approximately 1 small-class mission per decade. The NEO Surveillance Mission (NEOSM), a dedicated space telescope that addresses the congressional directive to find 90% of 140-meter NEOs (Mainzer 2020), is set to follow DART. However, current budget projections are not promising. Unless funding increases soon, NEOSM will not launch until the end of this decade, leaving little room for additional mission opportunities for the 2029 Apophis flyby.

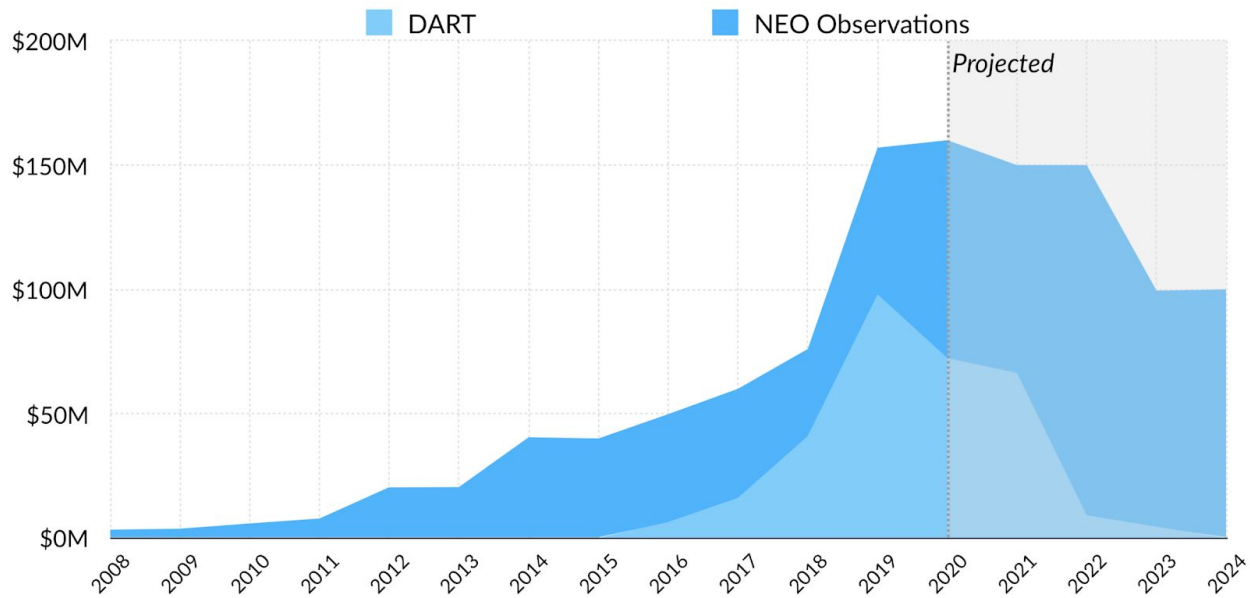


Figure 1. NASA NEO Observations/Planetary Defense program funding since FY 2008. The program grew from just a few million dollars per year to a peak of \$160 in FY 2020. The future is trending downward, however, and does not support a mid-2020s launch of NEOSM.

The Planetary Defense program currently accounts for 0.07% of NASA’s total annual expenditures and occupies less than 6% of the Planetary Science Division’s budget. Even a modest, sustained annual increase would substantially advance the schedule of NEOSM, support new planetary defense missions, and operate additional ground-based telescopes for NEO observations, such as the soon-to-come-online Rubin Observatory.

We do note that the majority of budgetary growth for planetary defense was due to the addition of a flight mission. This is not an accident. NASA is a mission-centric agency, and its staff, internal bureaucracy, and contractors have structural incentives to form coalitions around discrete missions and program lines. Beyond the individual value of any mission, *there is an institutional cachet associated with flying missions into space*. The planetary science community, which stands to benefit from the science returned from planetary defense missions, could strengthen this program by endorsing an ongoing mission line and outlining its scientific goals. This would help reinforce NASA’s institutional structures useful for expanding and sustaining funding in the future.

### **Apophis is an Opportunity to Grow the Budget and Scope of Planetary Defense**

The timeliness, self-interest, and public outreach opportunities around the 2029 close approach of Apophis are well known (SBAG 2019, Binzel 2020). This large asteroid will pass very close to Earth and present opportunities to validate theories about the

composition of NEOs and their dynamical origin. An Apophis mission (or missions) would also be a “dry run” of marshaling a response to a newly-discovered, potentially hazardous asteroid. Apophis presents a clear, timely, single target by which to focus public and policymaker attention. It is estimated that upwards of 2 billion people will be able to see the asteroid in the evening sky. Such opportunities, historically, are conducive to growing the budget and scope of a program.

### **An Ongoing Mission Line for Planetary Defense—The *Defender* Program**

The various subjects of this paper—the public openness to disaster preparation, its support for planetary defense, the value of flight missions in building institutional support, and the Apophis opportunity in 2029—now converge.

The decadal committee, should it embrace the value of planetary defense as a scientific endeavor, would find great benefits by embracing a permanent, clearly-identified flight program for planetary defense.

For the purposes of this discussion, we propose the *Defender*<sup>1</sup> program, and grant it the following attributes:

- Frequent, competitively-selected mission opportunities *strictly* cost-capped at \$450 million or less, inclusive of launch and Phase E;
- Integration with other NASA efforts such as SIMPLEX competed missions, and projects within STMD to capitalize on the maturation of interplanetary smallsat technology and emerging small launch capabilities;
- Fixed-price contracting and flexible mission classifications to support partnerships between other agencies (namely the NSF and DoD), industry, academia, and other private partners;
- Directed research and technology investments to enable future *Defender* missions, including a NEO Data Analysis Program (NEODAP);
- A balance between fundamental science and practical detection/deflection technology development goals;
- The use of Apophis as its organizing goal for the coming decadal period.

NEOSM, already in development, would be considered the first *Defender* mission of the coming decadal period, with subsequent missions designed to take advantage of Apophis before, during, and after its close approach to Earth.

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<sup>1</sup> Or, if one prefers acronyms, DEFENDER: the “Defense of Earth From Exogenous NEOs Due to Early Reconnaissance”.

In order to maintain the programmatic balance within the Planetary Science Division, however, this line must be limited to small-to-midsized missions and be granted the flexibility to experiment with higher-risk partnerships with industry, academia, and international partners. This includes leveraging the opportunities presented by smallsats with SIMPLEx, fixed-price partnerships with the private sector, and sharing funding partners within the agency (such as STMD). We note that many planetary defense goals can be accomplished with sub-Discovery-class competed missions. For example, the Janus SIMPLEx mission plans to send two spacecraft to two binary NEOs for ~\$50 million (Scheeres 2019).

### **Ground-based Detection and Characterization Must Continue**

A key component of any planetary defense program is the detection and characterization of the full population of NEOs. In addition to a space-based telescope like NEOSM, additional ground-based capabilities provide complementary sampling, additional color information, and enhanced statistics. The Rubin Observatory has been identified as a robust companion to NEOSM; together these can achieve the congressionally-mandated goal of finding 90% of all NEOs 140-meters or larger within 10 years (National Academies 2019). When the Rubin Observatory comes online in 2023, it will expand the current suite of ground-based surveys monitoring the skies for NEOs (see a comprehensive list in the NEO white paper by Milam et al. 2020).

### **Conclusion**

Fully embracing planetary defense aligns the planetary science community with perhaps the most relevant and consequential effort by a national space program—preventing potentially catastrophic collisions from near-Earth objects. The increased awareness of the value of disaster preparation created by the COVID-19 pandemic and the upcoming close-approach of Apophis provides a framework by which to establish relevance with the public and policymakers.

The scientific community stands to benefit from any increased commitment to planetary defense, particularly via novel experiments in low-cost mission design and partnerships with other agencies and the private sector. By embracing an ongoing mission flight line the community would have the opportunity to establish scientific guidelines and to align itself with an activity that benefits from high public support.

By leveraging these external opportunities with planetary defense, the community can build a larger coalition of support for the effort both within NASA and without. Integrating

research with an ongoing flight program places planetary defense within a common management framework within the space agency. Devised properly, an expanded planetary defense program could become a keystone of NASA: a program responsive and agile, highly relevant to the public, and a new source of scientific opportunity.

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