PLANETARY DEFENSE

Observation Systems

Fortunately, mankind has not been completely negligent on the issue of tracking potentially threatening near-Earth objects (NEOs) and comets. In the United States, serious recognition of the threat of potential impacts with the Earth started to grow in the 1980s, and by the 1990s the U.S. Congress issued a mandate to NASA, tasking them to find and track 90% of all NEOs larger than 1 kilometer, in order to determine if any pose a threat to the Earth in the future. This mandate led to the development of the "Spaceguard" program, which is a loose alliance of survey programs which receive money from NASA to find and track NEOs.

The past decades of observation under these programs have provided a start to addressing this planetary challenge, but, as is seen from the asteroid population estimates discussed above, we are still far from identifying all the potentially threatening NEOs which populate our immediate neighborhood. Looking to greater challenges, these existing NEO survey programs are not designed to deal with the challenge posed by the second class of rarer, but potentially more threatening objects, long-period comets, which come from the farthest depths of the Solar System, and are, for all practical purposes, impossible to detect at their great distances.

To successfully tackle both of these threats, mankind must rapidly expand its sensory systems based on existing designs, while at the same time developing new technologies to handle threats outside of our current technological capability.

The best possible option is for the United States, Russia, and China to cooperate in a joint science driver program, the beginnings of which have already been put forward by the Russian government in the form of the Strategic Defense of Earth proposal to the United States.

This article is adapted from a 2012 LaRouchePAC pamphlet.

Existing Programs

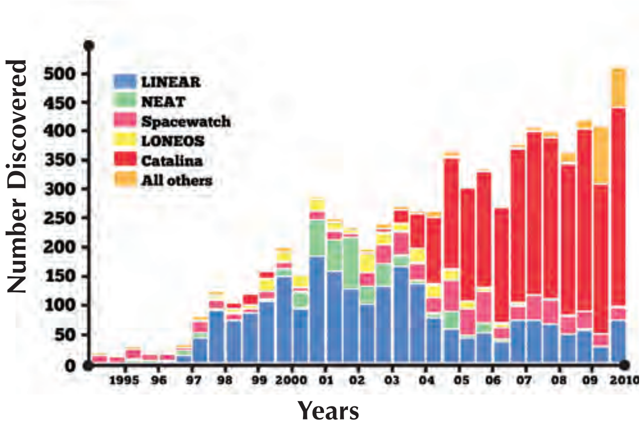
A series of ground-based observation programs have been developed to search for near-Earth objects. The following chart indicates how many near-Earth asteroids have been discovered each year and by which observation programs.

Observations from these and other telescopes are then centralized in the computer systems of the International Astronomical Union's Minor Planet Center (Smithsonian Astrophysical Observatory, Massachusetts). These systems, along with NASA's Jet Propulsion Laboratory (the Horizons Ephemeris Computation Facility) and the Near Earth Object Dynamics Site (NEODyS) at the University of Pisa, Italy, can then approximate the orbits of NEOs, and extrapolate their trajectories decades into the future.

These surveys and orbital extrapolations provide the first line of defense. Detecting a threat decades before it may impact would provide the necessary time to launch a mission to change the threatening object's trajectory.

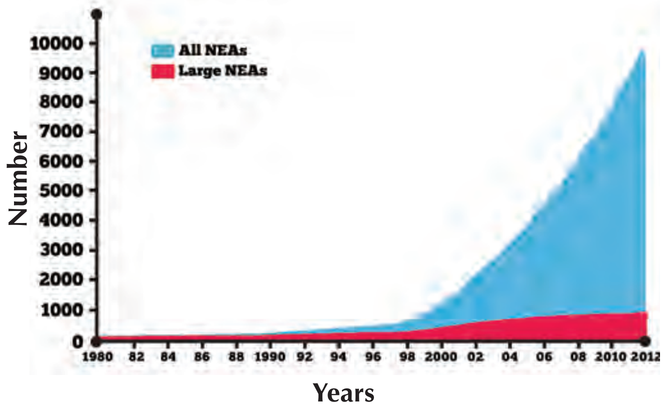
For these reasons, early warning is of the utmost im-

Yearly Discovery of Near-Earth Asteroids by Program



NASA, Data compiled by Alan Chamberlin

Known Near-Earth Asteroids (January 1980-June 2012)



NASA, Data compiled by Alan Chamberlin

portance. However, current computer simulations can not provide absolutely precise determinations of asteroid or comet orbits that far into the future, and instead provide a range of possible trajectories based on various uncertainties. While it is true that more observations lead to more accurate orbits, there are still limiting factors which keep scientists from achieving the accuracy needed. One crucial aspect of this problem is taken up in the interview with Claudio Maccone, on page 46 of this magazine.

In addition to ground-based observatories, the first steps have been made to utilize space-based telescopes to improve our view of the Solar System. This option was demonstrated with NASA's Wide-field Infrared Survey Explorer (WISE), an infrared space telescope which only operated for a short period of time, but opened a completely new window to view our neighboring asteroids and comets. Seeing these objects in the infrared end of the spectrum (which can only be done from space) provides an improved capability to determine their size, and to see small dark objects.

These first steps have been useful, but even with a decent discovery rate by present systems, it will take us decades to begin to come close to identifying the total population of near-Earth objects alone. It is time for nations to take up this challenge in a serious way. Up to the present, these efforts have been limited to a small number of concerned scientists who have demonstrated the existential importance of asteroid and comet defense. Their initial accomplishments could be rapidly expanded by an international mission.

Existing Proposals

In April of 2010, a NASA ad hoc task force was commissioned to advise the relevant agency officials on how best to further efforts to defend our planet from threatened NEOs. A short report was released in October of that year which provided a series of recommendations.[1]

Included in the recommendations is the construction of one or more space-based infrared telescopes dedicated to accelerating the detection and characterization of the NEO population. As discussed above, utilizing the infrared region of the spectrum provides an improved ability to see and identify these bodies. It was recommended that one or more of these infrared space telescopes be placed in orbit around the Sun, but at a distance similar to that of Venus. Because we can only see these objects when looking away from the Sun, this position, being inside the Earth's orbit, provides a better viewing angle to see a larger section of the NEO population.

This would be a significant step towards identifying and tracking the NEO population, but unfortunately NASA has not been able to take up this recommendation.[2]

This is a step in the right direction, but we must also consider what it will take to tackle the second class of problems, long-period comets. The 2010 NASA report on planetary defense chose to focus solely on the NEO threat, leaving out the issue of long-period comets, for the following reasons:

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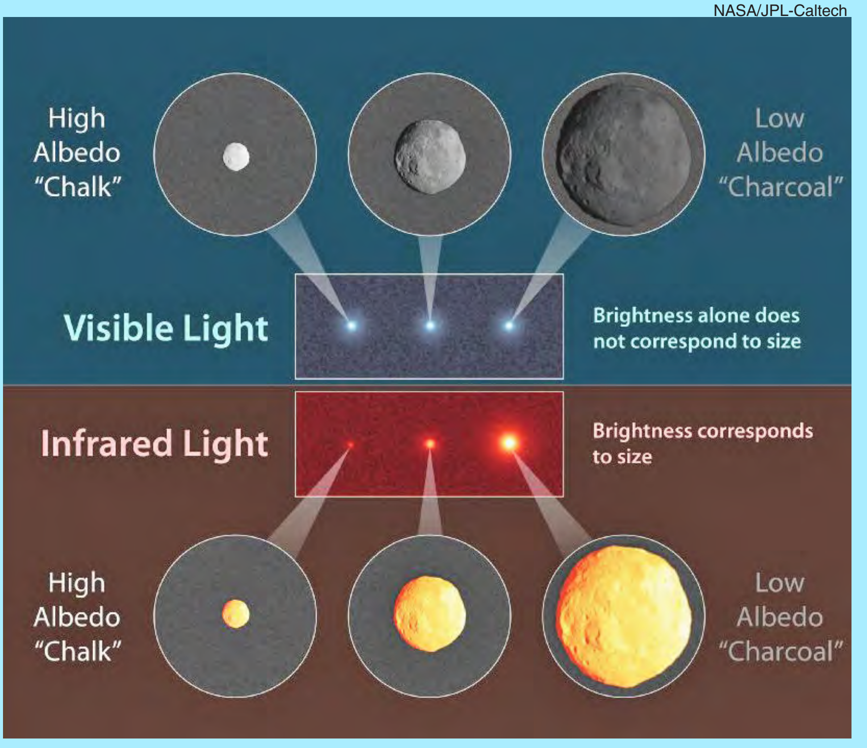
1. "Report of the NASA Advisory Council Ad Hoc Task Force on Planetary Defense;" October 2010.

2. Because of the inability of NASA to pursue this, a non-profit organization dedicated to the issue of planetary defense, the B612 Foundation (whose board of directors includes key participants of the 2010 NASA ad hoc report), has recently announced plans to build and launch an infrared telescope of this type supported by purely private funding. The "Sentinel Mission" is planned for launch in either 2017 or 2018.

How to Tell the Size of an Asteroid



This chart illustrates how infrared is used to more accurately determine an asteroid's size. As the top of the chart shows, three asteroids of different sizes can look similar when viewed in visible light. This is because when visible light from the Sun reflects off the surface of the rocks, the more reflective, or shiny, the object is (a feature called albedo), the more light it will reflect. Darker objects reflect little sunlight, so to a telescope from millions of miles away, a large dark asteroid can appear the same as a small, light one. In other words, the brightness of an asteroid viewed in visible light is the result of both its albedo and size.

The bottom half of the chart illustrates what an infrared telescope would see when viewing the same three asteroids. Because infrared detectors sense the heat of an object, which is more directly related to its size, the larger rock appears brighter. In this case, the brightness of the object is not strongly affected by its albedo, or how bright or dark its surface is. When visible and infrared measurements are combined, the albedos of asteroids can be more accurately calculated.

"The population of long-period comets, with orbits originating in the outer Solar System, represents a small part of the total comet threat, and thus an even smaller part of the total impact hazard. Because the tasks of effectively detecting and deflecting objects of this size and velocity are beyond our present technology, the Task Force report does not address long-period comets."

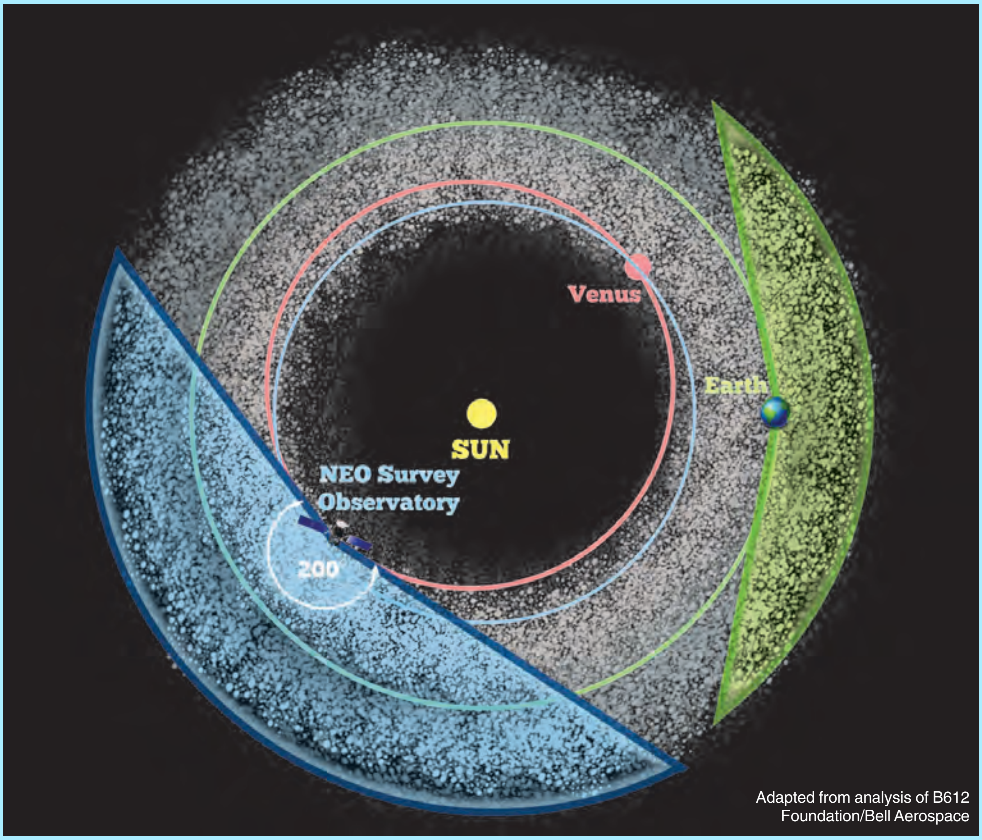
While long-period comets do have a lower frequency of impact, this does not mean that we should ignore the problem.

There have been preliminary investigations into what would be required for adequate detection times for long-period comets, most of which focus on developing space telescopes with much larger apertures to be able to see deeper into space. For example, one analysis discussed using light-weight structures to construct 25, 50, or even 75 meter telescope diameters.[3] This would be a dramatic improvement,[4] and is thought to allow us to look deep enough into space to provide warning times for long-period comets on the order of 6, 11, and 16 years respectively. Given the sizes and speed of many of these objects, even these warning times would be minimal, if not still too short.

These telescope designs are just two key examples of proposals to expand the observational capability in order to meet the demands posed by both NEOs and comets. Much more detailed analyses have been made for these and other systems, and more analyses can be done, but we must begin to move to the construction phase of such systems immediately.

3. "Obtaining long warning times on long-period comets and small asteroids—Extremely large yet extremely lightweight space telescope systems," Ivan Bekey, 2004 Planetary Defense Conference: Protecting Earth from Asteroids; Orange County, CA; Feb. 23-26, 2004.

4. The Hubble space telescope is 2.4 meters across, and the James Webb space telescope will have a diameter of 6.5 meters.



NEO Survey Observatory Placing a space telescope closer to the Sun, for example in an orbit similar to that of Venus, allows for a larger viewing angle to see near-Earth objects.

The Limits of Statistics

A 30m object impacts the Earth every 200 years, on average. Since the Tunguska event of 1908 was an object of about this size, does that mean we're able to relax until about 2108, the two hundred year anniversary of that event? No, not at all, although it reflects a common error people make when dealing with statistics. For example, the odds of tossing a coin and having it come up heads 100 times in a row is very low (1 in a million trillion trillion). Now, let's say that we've tossed it 99 times and gotten heads each time. Does this mean that tails is "hot" and more likely on the next toss?

No, not at all. In fact, the coin might be uneven, and prone to landing on heads! Similarly, the 200-year average time for 30m asteroids striking the Earth is only an average—it doesn't tell us anything about particular asteroids. To make real forecasts, we must move from statistics into specifics, from mathematics to physics.

Take an example in another field: earthquakes. Some who call themselves earthquake researchers claim that it is principally impossible to predict specific earthquakes, and that the best we can do is have ideas of which regions are most prone to earthquakes, and set building codes and insurance rates appropriately. Leaving aside the fact that the most damaging earthquakes between 2000-2011 were in supposedly "low-risk" zones, this approach means that there's no ability to actually understand the process itself.*

When it comes to asteroids and comets, we are already doing better by looking at thousands of specific objects, but we must aim higher still: to understand the asteroids *as an entirety, rather than as individual objects*. New, dynamic principles of the interrelation of these bodies, as a system, are to be a priority for the future pursuit of science.

* See the LaRouchePAC Report, *Planetary Defense: An Extraterrestrial Imperative*, **LaRouchePAC.com/PDReport** and "The Emerging Science of Earthquake Prediction" in the Winter 2011-2012 issue of *21st Century*.