Project NEOShield: Asteroid defence systems

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International cooperation under the leadership of DLR

It is not entirely clear when exactly the last major asteroid impact on Earth occurred. But there are plenty of examples of impact craters, such as the Nördlinger Ries in Bavaria. That there will be other collisions in the future is something of which Alan Harris, asteroid researcher at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR), is certain. Over the next three and a half years, he will be heading the NEOShield (Near Earth Object Shield) international collaboration, established in January 2012. In total, 13 partners from research institutions and industry will jointly investigate the prevention of impacts by asteroids and comets. The investigations will include the impact of a space probe with the asteroids to deflect them from their threatening courses. The European Union is supporting the project with four million Euros. The partners are contributing another 1.8 million Euros.

When asteroids approach the Earth, they typically do so at a speed of between five and 30 kilometres per second. “In order to modify their orbit and prevent a collision with Earth, a force must be exerted on them,” explains Alan Harris. "And at the precise time, as well." Existing examples of asteroids that have followed their natural course towards Earth include the Barringer Crater in Arizona, with a diameter of 1200 metres, or the Tunguska Region in Siberia, where an asteroid explosion in 1908 uprooted millions of trees. Smaller asteroids or comets could also cause this sort of damage. "The crater in Arizona was caused by an object about 50 metres in diameter." There are numerous near Earth objects, or NEOs. Thousands have been discovered in the last 20 years. "This means that a dangerous collision with Earth is likely every couple of hundred years," the asteroid researcher estimates.

NEOs in sight

A prerequisite to investigate possible methods for preventing an asteroid impact on Earth is the precise understanding of the physical properties of NEOs. "We want to find out as much as we can about the enemy that might be on course for Earth," says Harris. In this international project, the DLR planetary researchers are pooling their knowledge of the composition, structure and surface texture of asteroids and comets. Project leader Alan Harris’s team is also analysing observational data from the past two decades: "So far, the data has not been adequately investigated from the perspective of asteroid defence." To date, over 8000 NEOs have been discovered, and another 70 are found every month. By the end of the project we should have answers to a number of questions – for example, the asteroid researchers want to determine ways to observe threatening asteroids from the ground, and which space missions can be used to determine their properties. Various methods, which the scientists are investigating in detail, can then come into play, depending on the time between the discovery and the potential entry into Earth's atmosphere, and on the size of the asteroid.

Impacts on asteroids

One method that the NEOShield consortium will be investigating in more detail involves using a spacecraft to deflect an asteroid from its course by impacting it. "In my opinion, this is a very practical method." However, there are still many unanswered questions with this method that need investigating. How does such a space probe need to be controlled to reach its target reliably and at the correct angle? How can we minimise the effect that movements of fuel inside the space probe have on its impact? In addition, laboratory experiments in which projectiles will be fired at materials that correspond to those in an asteroid, will be carried out. This, in turn, will enable the scientists to draw conclusions on the behaviour of asteroids in such a collision.

Using gravity to change course

Scientists will also study a method to deflect asteroids on course for Earth without physically contacting them, if they are discovered years before their potential collision. If a spacecraft is guided into the direct vicinity of a potentially dangerous NEO, the added gravity might have an effect on the asteroid and, as if hauling it in on a rope, gradually drag it off course. But a period of several years would be required to achieve a significant change in the asteroid's orbit. "To date, this method only exists on paper, but it could work." The research to be conducted over the next three and a half years should show how realistic it is to drag threatening asteroids off track using gravity tractors.

Explosive power in space

Alan Harris would only consider this alternative method if time is pressing: "If a very large, dangerous object with a diameter of one kilometre or more is discovered, the two methods described above would probably not solve the problem," explains Harris. "The greatest force we would be able to use to divert the asteroid from its path would be a nuclear explosion." Though there are no actual plans for a mission of this kind, this is a solution that the scientists want to investigate as part of their project. However, they want to know the effects that an explosion in the direct vicinity of an asteroid or on its surface would have in the vacuum of space. "This technique is regarded as a very controversial."

Proposals for space missions

Data from asteroid observations and the results of laboratory experiments, extrapolated to a realistic scale, are continually being added to computer simulations. At the end of the three and a half years, we should not only have a better understanding of asteroids and a possible method of defence. "We are also planning international space missions in a few years to test the defence methods we have been looking into." From the large number of asteroids discovered, those that are most suitable for a test mission will be selected for this. Furthermore, there should be a roadmap that could be put into action in the event of a threat to Earth from an asteroid collision. This would be based on realistic events, such as the approach of asteroid Apophis – the orbit of which will bring it dangerously close to Earth in 2029.

The partners

Under the leadership of the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR), the following partners are participating in the EU's NEOShield project: Observatoire de Paris (France), Centre Nationale de la Recherche Scientifique (France), The Open University (Great Britain), Fraunhofer Ernst-Mach-Institut (Germany), The Queen's University of Belfast (Great Britain), Astrium GmbH (Germany), Astrium Limited (Great Britain), Astrium S.A.S. (France), Deimos Space (Spain), SETI Institute Corporation, Carl Sagan Center (USA), TsNIIMash (Russia), University of Surrey (Great Britain).

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Asteroids in space

When asteroids approach Earth, they typically do so at a speed of between five and 30 kilometres per second. Thousands of near-Earth objects (NEOs) have been discovered in the past 20 years.

Credit: NASA/JPL-Caltech.

Barringer Crater

The consequence of an asteroid's collision with Earth are clear; the 1200-metre diameter Barringer Crater in Arizona is the result of an impact with an asteroid 50 metres in diameter.

Credit: Stefan Seip.

The Tunguska region in Siberia

In 1908, an asteroid explosion uprooted millions of trees in Siberia's Tunguska Region.

Credit: Russian Academy of Sciences/L. Kulik.

NEOShield - hunting for near-Earth asteroids and comets

NEOShield, an international cooperation being led by DLR, will investigate the properties of near-Earth objects and develop a strategy to prevent collisions with Earth.

Credit: NASA/JPL/JHUAPL (Montage: DLR).

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