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Potential threat of asteroid impact should unite international community

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Scientists of the Russian Academy of Sciences continue to investigate the meteorite explosion recorded in the Chelyabinsk region near the Chebarkul lake on 15 February 2013, after which more than 1.5 thousand people sought medical care. Modern methods of detection of celestial bodies have been unable to predict this threat, prompting the international community to focus more closely on this area of space research.

“Today’s event is a strong reminder of why we need continuous efforts to survey and identify near-Earth objects,” said Thomas Reiter, European Space Agency’s Director of Human Spaceflight and Operations.

The current Russian Deputy Prime Minister Dmitry Rogozin spoke on the need for detection of potentially hazardous celestial bodies way back in 2011. Then being Russian president’s special envoy for missile defense, he suggested to refocus the US missile defense system, placed in Europe, on asteroids.

“I have spoken before about the need for some kind of international initiative, related to establishing a warning and prevention system for dangerous approaches to Earth by objects of extraterrestrial origin. It is better not to wait for the new incidents but address the issue in advance,” he said after the meteorite explosion in the Chelyabinsk region, stressing that neither Russia nor the US has such a system so far.

At the same time Lamar Smith, Chairman of the Committee on Science, Space and Technology of the United States House of Representatives, suggested the need for further investment in space science.

“We should continue to invest in systems that identify threatening asteroids and develop contingencies, if needed, to change the course of an asteroid headed toward Earth,” he said in reaction to meteorite impact in Russia, and asteroid’s 2012 DA14 close brush with Earth.

According to Professor Vyacheslav Emelianenko, the lead researcher of the Institute of Astronomy of the Russian Academy of Sciences, the Chelyabinsk event showed mainstream audience that the space threat is real, while previously it was clearly understood only by a narrow circle of specialists.

“The fall of the meteorite in Chelyabinsk is associated with entry into the atmosphere of the cosmic body, which, according to preliminary estimates, had a diameter of about 15–17 meters. This meteorite belongs to the most common class of ordinary chondrites. At the present stage of development of astronomical equipment it was almost impossible to predict such an event in advance: even the best telescopes could detect such a small body only 2–3 hours prior to its collision with the Earth. However, the number of such telescopes in the world is not enough to survey the whole sky. In addition, the meteorite came from the Sun, and it is impossible to search the sky in the direction of the Sun,” he said in an interview with news agency “PenzaNews.”

The professor also stressed that all modern developments to counter this kind of threat are based on early detection of a dangerous object and are theoretical.

“The well-known methods are aimed either at the destruction of a hazardous object or at its moving out of an Earth-impacting orbit. The possibility of kinetic impact, gravity tractor, nuclear explosion, a special reflective coating to change the influence of solar pressure and other ways were described in the academic literature,” explained the lead researcher of the Institute of Astronomy.

According to Vyacheslav Emelianenko, intensification of international cooperation is crucial in creation of a system to counter space threats.

“Currently, the overwhelming contribution to detection and monitoring of hazardous NEOs is made by the US, but even the financial resources of this country are insufficient to fully address the problem. Moreover, asteroids and comets may threaten different parts of the planet, so the problem is global. Even the placement of detection and reaction systems in different countries requires their coordination and cooperation,” he said.

Margaret Campbell-Brown, an associate professor at the University of Western Ontario and a member of the Western Meteor Physics Group, studied data from two infrasound stations near the impact site after the meteorite explosion. The analysis allowed her to conclude that it was “the biggest object recorded to hit the Earth since Tunguska.” However, the expert shared the opinion of the Russian scientist that it was almost impossible to see the object before it approached the Earth too closely.

“The February 15 object could not be observed before impact because it came from the direction of the Sun, and telescopes could not observe it through the glare. Even if it had been on another trajectory, it would have taken luck to discover it before impact. Space-based telescopes – like the Canadian NEOSSat which is scheduled to launch shortly – have an advantage here, in that they can look closer to the Sun than ground-based systems, but there are no space observations currently dedicated to finding near-Earth objects,” Margaret Campbell-Brown said.

In her opinion, the Chelyabinsk event reminded all the people that “space is not as remote from our daily lives as we think.”

“We definitely need to be aware of this planetary danger, and it would be to all our advantages to have a global plan in place to use when a potentially hazardous object is discovered,” she emphasized.

Meanwhile, Michael Busch, jansky fellow at the US National Radio Astronomy Observatory, suggested that members of the world astronomical community are in close interaction with each other.

“The loosely-organized Spaceguard effort to discover, track, and characterize near-Earth asteroids includes astronomers from the US, Canada, Australia, Chile, Japan, China, many of the member states of the EU, and from Russia. All near-Earth asteroid discoveries are submitted to the International Astronomical Union’s Minor Planet Center, which immediately publishes them to a worldwide audience,” he explained.

According to the expert, near-Earth object discovery programs to date have focused on finding larger objects and there are well-developed plans for deflecting them decades in advance of a potential impact.

“The first stage is to obtain additional information on the object’s trajectory, to confirm that it will indeed hit the Earth. The second stage would be to construct and launch a deflection spacecraft, which would work either by a slow gravitational deflection of the object or by a high-velocity impact to give an immediate push. No large asteroid so far discovered has a potential impact in the next several decades that remained possible after additional information was obtained, so construction of a deflection spacecraft has not been necessary. Note the timescale here – with decades of warning, there is plenty of time to build the deflection spacecraft after the future impact is confirmed,” Michael Busch said.

“For small objects, it is not feasible to discover future impactors decades in advance of their impacts. Almost all of them will not approach close enough to Earth to be seen at any time until just before they are going to hit. The indicated procedure is to find them a few days or perhaps two weeks before the impact, and either evacuate the blast zone or at least warn everyone in it to stay indoors and away from windows. Providing such warning for a large fraction of future impacts is one of the goals of the ATLAS project, being built by a team led by Robert Jedicke at the University of Hawaii,” he added.

In turn, Robert Jedicke himself explained news agency “PenzaNews” that ATLAS is a ground-based early warning system for asteroid impacts.

“Our simulations suggest that the system will be very effective at finding asteroids larger than about 50 meters diameter before impact. Finding objects the size of the Chelyabinsk meteor is more difficult but still possible with ATLAS. ATLAS could be improved by building more ATLAS systems around the world distributed in longitude and latitude so that we could monitor the entire sky all the time. In addition, ATLAS could be improved by using bigger and more telescopes to identify smaller objects. The big problem is that from the ground there is no way to search the sky in the direction of the Sun and about one third of all impacting asteroids will approach from that direction. That is why the ultimate solution is a space-based survey,” the astronomer said.

Robert Jedicke noted that scientists and engineers have been working for years on ideas on how to modify an asteroid’s trajectory.

“In fact, a semi-annual international meeting on the subject will take place in April in Flagstaff, Arizona, the US. There are many good ideas but there have been no tests of the technology. So that’s what we need to do – test the technology on smaller asteroids that are not impactors to verify that the deflection can take place if necessary,” he emphasized.

Another project to protect the planet from asteroid threat is NEOShield project financed by the governments of the EU member states. According to Professor Alan Harris, German Aerospace Center Senior Scientist and NEOShield Coordinator, NEOShield project aims to address in detail realistic options for preventing the collision of a near-Earth object with the Earth.

“The primary aim of NEOShield is to investigate the feasibility of promising mitigation options and provide detailed designs of mitigation test missions for the most feasible concepts. The NEOShield project does not have sufficient funding for a test mission, but we hope that this funding may become available at a later stage. The NEOShield project also includes studies of the nature and physical properties of NEOs using laboratory impact experiments on materials thought to make up asteroids and associated modeling. The results of this work will help us to understand how an asteroid may respond to a mitigation technique, such as the “kinetic impactor,” Alan Harris explained.

Meanwhile, Charley Lineweaver, an associate professor at Mount Stromlo Observatory, noted that the Chelyabinsk event was the first recorded case of people being injured by space debris of any kind.

According to him, the survey of objects with a diameter that does not exceed 100 meters is less that 1% complete.

“This field would be more developed if these surveys had higher budgets. For the past 20 years, these surveys have been making steady progress. Many techniques, which may help to move an asteroid out of an Earth-impacting orbit, have been thought about and discussed. As in preventing cancer, the most important aspect of protecting Earth is “early detection” and calculating precise trajectories. To promote early detection and establish better trajectories better survey equipment is needed – bigger telescopes with wide fields of view and an observational cadence appropriate for detecting near earth objects,” Charley Lineweaver said.

According to Professor Richard Crowther, the chief engineer at the UK Space Agency, funding priorities in the space industry are focused primarily on the study of large objects down to 1km in size – the so-called planet killers.

“There are concepts [aimed to save the planet], which might be effective depending on the time we have to respond before impact, and the maturity of the technologies needed. However, these developments are at conceptual stage. It is worth noting that we would have had less than a year to deflect 2012 DA14,” he said.

In his opinion, this issue is global in both scale and nature, and requires an international response involving all nations, whether space-faring or otherwise, in developing appropriate scientific, technical and policy solutions.

“The UN has been considering this issue since 2007 in its NEO Working Group. Number of recommendations is likely to be produced by the UN to establish operational entities for NEO detection, tracking, and deflection/mitigation. Russian Federation has been a very proactive member of this UN group, and has provided critical scientific and programmatic insights based on its extensive space experience. It would be hoped that Russian Federation would be a leading actor in these future entities,” Richard Crowther concluded.
