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Item 12 of the provisional agenda*
Near-Earth objects

Information on research in the field of near-Earth objects carried out by Member States, international organizations and other entities

Note by the Secretariat

I. Introduction

1. At its forty-eighth session, in 2011, the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space endorsed the agreement of the Working Group on Near-Earth Objects to continue its multi-year workplan in 2012 and 2013 (A/AC.105/987, para. 165). In accordance with the workplan, the Subcommittee will, at its forty-ninth session, in 2012, consider reports submitted in response to the annual request for information from member States, international organizations and other entities on their near-Earth object (NEO) activities (A/AC.105/987, annex III, para. 9).

2. The present document contains information received from Japan and the United Kingdom of Great Britain and Northern Ireland and the Committee on Space Research, the International Astronomical Union, the Secure World Foundation and the Space Generation Advisory Council.

* A/AC.105/C.1/L.310.

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II. Replies received from Member States

Japan

[Original: English]
[31 October 2011]

Near-Earth objects project

Japanese NEO activities started with the establishment of the Japan Spaceguard Association (JSGA) in 1996. JSGA constructed a 1-metre-wide field telescope for NEO detection, which became operational in 2002 and was used mainly for follow-up observations. JSGA improved the telescope in 2006, and it is now able to detect NEOs down to a magnitude of 20.5, which is comparable to detections by the Catalina Sky Survey and the Spacewatch programme in the United States of America. A list of NEO follow-up observations is shown in the table.

Near-Earth object observations by the Japan Spaceguard Association (as at September 2011)

	Near-Earth asteroid (NEA)			*Comets*	
Year	*Number of observed objects*	*Number of position measurements*	*Sum of position measurements*	*Number of observed objects*	*Sum of position measurements*
2000	23	205	4 240	20	113
2001	29	560	5 907	16	275
2002	24	243	2 018	13	339
2003	54	567	4 938	18	165
2004	23	233	2 908	4	20
2005	8	42	2 431	0	0
2006	25	297	3 224	5	66
2007	34	408	7 219	15	108
2008	31	162	4 534	14	110
2009	26	138	5 796	7	37
2010	135	924	3 545	10	50
2011	196	1 280	2 602	21	186
Total	**608**	**5 059**	**49 362**	**143**	**1 469**

JSGA has performed various educational activities over the past 10 years. For public outreach, it has produced an educational package on NEO detection in English, Japanese and Spanish and has published two books and a number of articles in journals and newspapers. On 12 June 2011, the first anniversary lecture was held to mark the return of the Hayabusa capsule to Earth. The lecture included a presentation of the light curve observations and multiband photometry for 107P/Wilson-Harrington, and the results have shown physical properties of candidate objects for future asteroid exploration. In 2011, JSGA organized lectures on the theme “Spaceguard 2011” in four different locations in Japan and published the fourth issue of its bulletin, *Spaceguard Research*.

Hayabusa mission

Another important NEO activity is the Hayabusa mission to the NEO Itokawa. The purpose of the mission is to gain information on the mysteries behind the genesis of the solar system and on possible evidence of life; to achieve this, technology to bring back samples of asteroids is essential. Hayabusa reached Itokawa in 2005 and collected many images and other scientific data; it also attempted to touch down and collect surface material.

On 13 June 2010, the asteroid-sample capsule of the Hayabusa spacecraft returned to Earth containing the surface material of Itokawa. The material was analyzed by the analysis team of the Hayabusa Science Team. The results of the mission are important not only for science but also for Spaceguard, as Itokawa is an asteroid of the type that may come close to the Earth, and this mission is the first to have studied such an asteroid. The Japan Aerospace Exploration Agency is now considering another NEO sample return mission, Hayabusa-2, which, if successful, would provide information about another type of NEO. The Hayabusa-2 mission that started in May 2011 is planned for launch in 2014 or 2015 and is planned to arrive at the target asteroid in 2018.

United Kingdom of Great Britain and Northern Ireland

[Original: English]
[2 November 2011]

The United Kingdom Space Agency maintains an active role in addressing the NEO problem by encouraging coordination at the national, European and international levels to reach agreement on understanding and development of effective measures to address the threat posed by NEOs. This leadership role has been demonstrated by, among other things, the United Kingdom's past chairing of the Action Team on Near-Earth Objects and the Working Group on Near-Earth Objects of the Committee on the Peaceful Uses of Outer Space.

The United Kingdom has strong NEO research capabilities in addition to its astronomy, planetary science and space surveillance capabilities, which the UK Space Agency regularly calls upon for impartial technical support and advice. During the past year, United Kingdom organizations have conducted a wide range of activities, a number of which are summarized below.

Remote observation and measurement of the near-Earth object population

Astronomers at Queen's University Belfast continue to obtain astrometry of NEOs that have been identified as presenting a small risk of hitting the Earth in the next 100 years, with the aim of improving their orbits.

The Open University continues to be engaged in research related to light curves of slowly rotating (mostly main belt) asteroids, using data from the Super-Wide Angle Search for Planets sky cameras, and continues to publish NEO observation results (thermal modelling and infrared spectroscopy).

In situ observation and measurement of the near-Earth object population

At the Open University, in addition to theoretical studies aimed at understanding the formation of smaller bodies in the solar system, a number of experimental programmes are also under way. Among them is the development of a penetrometry rig to simulate a high-mass, low-speed impact of a penetrometer fixed to a landing spacecraft. Penetrometers will be key to enabling in situ measurements of an NEO surface, which is likely to be delicate, in order to give the structural and mechanical information necessary for successful mitigation and negation of the body. More broadly, the Open University has an interest in instrumentation for the in situ physical and geochemical investigation of NEOs and other smaller solar system bodies. Open University research on NEOs also continues in the field of meteoritics and extraterrestrial sample analysis, using its world-class suite of geochemical laboratories, which forms part of the United Kingdom Cosmochemical Analysis Network (UKCAN).

Risk assessment

The Astronautics Research Group at the University of Southampton is conducting a significant amount of research into the effects of NEO impacts on the Earth. The NEO research programme at Southampton is aimed at assessing the global threat to Earth posed by small NEOs with a diameter of less than 1 kilometre. An NEO impact can affect the Earth's ecosystem and have serious consequences for the human population. The primary challenge of the research is accounting for each impact-generated effect and developing an adequate model to simulate it. To this end, the computer simulation tool under development has the capability of modelling small NEO impacts. This tool tackles the hazard on both a local and a global scale, tracking the consequences of an impact on the human population. Each of the impact-generated effects will affect the human population and infrastructure to varying degrees. Therefore, the analysis of mortality rates and infrastructure cost is the key feature of the simulation. Overall hazard assessment of an NEO impact event will be rated by the casualty figures and level of infrastructure damage. This work is complemented by research within the Department of Earth Science and Engineering at Imperial College London on characterization of the direct effects of NEO impacts. This research is partly supported by the Natural Environment Research Council.

Mitigation

The objective of work conducted by the University of Glasgow is to develop fundamental optimal control theory and to apply it to the interception of hazardous NEOs. Different parameters, time, mass, orbital corrections, maximum deviation, and so forth, are optimized. A study of the robustness of the methods is also performed to take into account the uncertainties of both NEO dynamics and boundary conditions. A variety of propulsion methods, ranging from solar sails to nuclear propulsion, are considered, and the advantages and disadvantages of each are assessed. Numerical simulations in a realistic scenario are developed in order to investigate the performance of such methods, and, in order to evaluate the optimal trajectories and deviation methodologies, the simulation data are animated. This programme was funded by the Engineering and Physical Sciences Research Council.

Information dissemination

The United Kingdom continues to be home to two centres providing information on NEOs to the public and media.

One is the Spaceguard Centre, located at the former Powys Observatory, near Knighton, Wales. It represents the Spaceguard Foundation as the International Spaceguard Information Centre. It has set up the nationwide Comet and Asteroid Information Network and has a well-established outreach programme. It currently liaises with Spaceguard organizations in other countries and encourages the establishment of new ones. The Centre is also the primary science adviser for the Faulkes Telescope Asteroid Project and is developing a robotic NEO astrometry system (Spaceguard NEO Astrometry Project), deployed in Kenya and the United Kingdom.

The other is the United Kingdom Near-Earth Object Information Centre, which was established in response to recommendations 13 and 14 of the report of the United Kingdom Government's Task Force on Potentially Hazardous Near-Earth Objects. The Information Centre is operated by a consortium led by the National Space Centre, under contract to the UK Space Agency. The main centre is based at the National Space Science Centre in Leicester, which houses an NEO exhibition and provides a primary contact point for public and media enquiries. The Centre is advised by a network of academic institutions active in the field of NEOs: Queen's University Belfast, the United Kingdom Astronomy Technology Centre in Edinburgh, the Natural History Museum in London, Queen Mary University of London, Imperial College London and the University of Leicester. In addition, there are three regional centres with linked exhibits and access to the Information Centre facilities. These are based in W5 in Belfast, the Natural History Museum in London and the Royal Observatory in Edinburgh. The website of the Information Centre (www.spacecentre.co.uk/Page.aspx/6/NEAR_EARTH_OBJECTS/) provides a virtual exhibition, a resources section (for educators and the media) and the latest NEO news, including answers to frequently asked questions. The site also allows access to the Task Force report.

Policy approach

The underlying policy approach to NEOs in the United Kingdom is recognition that the threat they pose is real, but that, although potentially catastrophic, impact by an NEO is a low-probability occurrence. It also recognizes that such objects do not respect national boundaries and that the scale of their effect is such that the NEO hazard is a global issue and can be effectively addressed only through international cooperation and coordination.

III. Replies received from international organizations and other entities

Committee on Space Research

[Original: English]
[7 November 2011]

NEOs are objects orbiting the Earth at perihelion distances of less than 1.3 astronomical units. The NEO population is constantly evolving and being replenished from the main asteroid belt and cometary reservoirs. It consists of objects with a variety of compositions and internal structures. As at 20 October 2011, 8,345 NEOs had been discovered. Among them, some 832 are asteroids with a diameter of approximately 1 kilometre or more, and 1,258 have been classified as potentially hazardous asteroids, indicating a possibility that they might threaten the Earth. The number of NEOs discovered per year is shown in the original document submitted by the Committee on Space Research, which can be found on the website of the Office for Outer Space Affairs of the Secretariat (www.unoosa.org).

Nowadays, NEOs are discovered through automated, ground-based observational programmes. The Panoramic Survey Telescope and Rapid Response System (Pan-STARRS) is an astronomical survey that is continuously conducting astrometry and photometry of much of the sky to detect NEOs that could threaten the Earth.

The National Aeronautics and Space Administration (NASA) Wide-field Infrared Survey Explorer (WISE), although designed primarily for astrophysics science objectives, is providing a large amount of data on small objects. The WISE all-sky survey is also detecting most of the known main belt asteroids, providing accurate radii and albedos for over 100,000 objects and detecting many new ones. The NEOWISE programme, which is a supplementary analysis programme, is also discovering and characterizing many new NEOs on a daily basis.

Space missions involving near-Earth objects

The Origins Spectral Interpretation Resource Identification Security Regolith Explorer project was among the three missions selected by NASA in 2010 for the second round of the next New Frontiers mission competition. It is designed to orbit a primitive near-Earth asteroid (NEA) and bring a sample back to Earth for study.

The MarcoPolo-R mission has been selected for the assessment phase for the third medium-class mission of the European Space Agency. The primary objective of the MarcoPolo-R mission is to return a sample from a NEA.

Potentially hazardous asteroids

As of October 2011, two potentially hazardous asteroids, classified with level 1 (no unusual level of danger) under the Torino Impact Hazard Scale are known and are being monitored: 2011 AG5 and 2007 VK184.

International Astronomical Union

[Original: English]
[5 October 2011]

Activities of the International Astronomical Union Minor Planet Center

In 2011, there were many activities at the Minor Planet Center. The NASA Wide-field Infrared Survey Explorer (WISE) project successfully completed routine operations searching for minor planets in the infrared spectrum. The optical ground-based NEO surveys continued their operations. At present, the discovery rate of NEOs is higher than in the past, with around 1,000 to 1,200 NEOs being discovered annually. This is largely due to the increase in discoveries of the Panoramic Survey Telescope and Rapid Response System (Pan-STARRS) survey project, which is operated by a consortium of institutions, led by the University of Hawaii.

The main discovery team of NEOs is the Catalina Sky Survey programme which uses two telescopes in Arizona, finding approximately 600 to 800 NEOs annually, while the Pan-STARRS team finds approximately 250 to 300 of the expected 1,000 to 1,200 NEOs discovered in 2011. Both teams collaborate well by sharing their sky coverage to allow more efficient use of telescope time to cover areas not seen by other surveys.

An example of how both surveys, the Catalina Sky Survey and Pan-STARRS, and the Minor Planet Center are handling the increase in near-miss objects is a small asteroid, 2011 MD, with a size of about 10 meters, which passed just about 12,000 km from the Earth surface in June 2011. This object was picked up a full two days before the closest approach and identified as a near-miss object by the computers of the Minor Planet Center soon after the discovery.

There is also vibrant ongoing cooperation worldwide among the follow-up observers in targeting NEOs that need orbital improvement. The Minor Planet Center has a blog that allows observers to post real-time information on their follow-up efforts, which contributes to better distribution of resources on the fly. In sum, each year more NEOs are being discovered, and each year, the NEO population is studied more closely, as well.

The International Astronomical Union website continues to have a page on NEAs, which includes past and future approaches of NEAs close to the Earth, milestones in NEA research and information on related conferences as well as scientific literature (see www.iau.org/public/nea/).

Secure World Foundation

[Original: English]
[30 August 2011]

The Secure World Foundation (SWF) has been working to facilitate discussions on governance issues related to the deflection and mitigation of potentially threatening NEOs. In May, SWF sponsored the 2011 IAA Planetary Defense Conference in Bucharest. SWF Technical Advisor Brian Weeden co-chaired a session on the legal

and policy frameworks for planetary defence. In August, SWF co-organized an Action Team on Near-Earth Objects workshop on international recommendations for NEO threat mitigation, which included discussion of a draft terms of reference for a mission planning and operations group, a key recommendation of the 2008 report of the Association of Space Explorers presented to the Committee on the Peaceful Uses of Outer Space.

Space Generation Advisory Council

[Original: English]
[2 November 2011]

As a member of the Action Team on Near-Earth Objects, the Space Generation Advisory Council (SGAC) recognizes the importance of the work of the Working Group on Near-Earth Objects and strongly supports its efforts. As outlined in the workplan of the Working Group for 2009, the International Year of Astronomy acted as a framework for raising awareness of NEO issues among the public, in particular among young people. Understanding that young people need to be made aware of these issues, SGAC continues to work on outreach programmes to increase their involvement beyond the International Year of Astronomy (2009). The SGAC NEO Working Group increased its team size in 2011 as several SGAC members expressed interest in the Group's work and joined.

The "Move an Asteroid" technical paper competition, held annually since 2008 by SGAC, requires students and young professionals to send in novel proposals on how to either detect or deflect an asteroid, or establish a global impact warning system. The 2011 edition winner of the competition, Alison Gibbings, a PhD student from the United Kingdom, focused on an asteroid deflection technique and was interviewed on National Public Radio in the United States. The entries were reviewed by experts, and the winner of the competition was awarded a trip to present the paper at the SGAC annual congress, the Space Generation Congress, as well as at the International Astronautical Congress, both of which were held in Cape Town, South Africa. The Space Generation Congress is held in conjunction with the International Astronautical Congress and provides the winner with the opportunity to present the winning paper to a larger audience. Through this competition, young people proactively participate in NEO activities and analyse the issues surrounding them.

SGAC was an official co-sponsor of the 2nd Planetary Defense Conference, which was held in May 2011 in Bucharest, and two SGAC members were on the organizing committee. The day before the Planetary Defense Conference, the SGAC NEO Working Group held a public outreach event, entitled "Future of planetary defense", at the Polytechnic University of Bucharest. About 150 students attended this public event, which was focused on four high-level speakers: Bill Ailor, Marius-Ioan Piso, Dumitru Prunariu and Rusty Schweickart. The event was well covered by local national media, and interviews were featured on several national Romanian television programmes. The NEO public awareness documentary that SGAC created from expert interviews during the 1st Planetary Defense Conference in 2009 was also shown during the event. The documentary is available on the SGAC YouTube channel and continues to have many monthly views.

SGAC intends to continue raising awareness and involving young people in the NEO field, as well as informing the public about current NEO issues, including the work of the Action Team on Near-Earth Objects. SGAC is convinced that an informed public, specifically young people, can have a positive impact on finding solutions to the challenges presented by NEOs.