Space Policy 29 (2013) 234–237

Contents lists available at SciVerse ScienceDirect

Space Policy

journal homepage: www.elsevier.com/locate/spacepol

European space research in support of international partnership

P. Rosa [a], P. Ehrenfreund [b,*], G. Horneck [c], G. Thiele [d]

[a] NAV-Portugal, EPE, 1700-008 Lisbon, Portugal
[b] Space Policy Institute, George Washington University, 1957 E Street NW, Suite 403, Washington DC 20052, USA
[c] German Aerospace Center DLR, Institute of Aerospace Medicine, 51170 Cologne, Germany
[d] European Space Policy Institute, A-1030 Vienna, Austria

ARTICLE INFO

Article history:
Received 10 March 2013
Accepted 17 June 2013
Available online 17 July 2013

Keywords:
Space exploration
International Space Station
Climate change
International cooperation
European Commission
Space policy

ABSTRACT

The envisaged future space research programmes, whether in the field of space exploration or Earth observation are becoming more and more technically complicated and so costly that a single nation can hardly afford to realize them. Major non-European space-faring nations, China and India will progressively play an important role besides US, Russia and Japan. The Space Advisory Group of the European Commission recommended that the European Commission supports within Horizon 2020 a comprehensive Robotic Mars-Exploration Programme under European leadership that should become an essential element of a coordinated international space research programme. The International Space Station (ISS) experience shows that cooperative space programmes build links between industries and laboratories from around the world, which then further develop in non-space related activities, with positive impact on the economy and scientific research. Strategies need to be developed to mitigate the gradual increasing risks incurred by climate change. In order to lower their entry barrier to engage in space emerging and developing space nations need to be included in cooperative space programmes. We present the recommendations of the Space Advisory Group of the European Commission concerning Europe's participation to global space endeavours.

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1. Introduction

The European Union's future funding programme for research and innovation, Horizon 2020, will run from 2014 to 2020 with a proposed €80 billion budget [1]. It includes among other topics the theme "Space" within the Directorate Enterprise and Industry of the European Commission. An average annual budget of 240 M€ is foreseen in the European Commission proposal for the space theme to cover the next 6 years period. A separate Space theme was first included in the preceding Seventh Framework Programme (FP7) with two main topics dedicated to "Global Monitoring for the Environment and Security" (GMES, recently renamed to Copernicus) [2] and "Strengthening Space Foundations". This has marked the start of support for space research by the European Commission.

In the search for strategic advice regarding the Space theme the European Commission established the Space Advisory Group (SAG) since the start of FP7. The SAG is composed of individual members from science and industry with expertise from the different areas of space. One example of a previous SAG advice to the European Commission is the recommendation to develop a European vision for space exploration, which was prepared in view of the emerging international interest in this research field [3].

With regard to the future Horizon 2020 programme, the SAG produced detailed advice on the substance and context of the dedicated Space theme to meet its overall objectives:

1. Enabling European competitiveness, non-dependence and innovation of the European space sector;
2. Enabling advances in space technologies;
3. Enabling exploitation of space data;
4. Enabling European research in support of international space partnerships.

In this context, the Space theme within Horizon 2020 should be balanced with two main pillars, namely "Space for exploring the Solar System and the Universe" and "Space for Grand Challenges on Earth", with 40–50% of the annual budget dedicated to the first pillar, and 35–45% to the second one. These main topics should be complemented with the ancillary elements "Enabling technologies" and "Crosscutting activities" [4].

* Corresponding author. Tel.: +1 202 994 1637.
E-mail addresses: pedro.rosa@nav.pt (P. Rosa), pehren@gwu.edu, p.ehrenfreund@chem.leidenuniv.nl (P. Ehrenfreund), gerda.horneck@dlr.de (G. Horneck), gerhard.thiele@esa.int (G. Thiele).

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http://dx.doi.org/10.1016/j.spacepol.2013.06.011

In this paper SAG's views concerning objective four "Enabling European research in support of international space partnerships" are discussed. Essentially benefitting from the cooperation and interaction of space and Earth based activities, multidisciplinary and multinational efforts in space have shown to be eminent. In order to achieve the highest possible results in this domain Europe needs a coherent and forward looking inspirational space strategy encouraging and facilitating the integration of new actors and programmes including Horizon 2020 in the international space landscape.

2. Scope for an intensified cooperation in space

Europe has developed over the last decades a well-established recognition as a soft power rather than a hard or military power. Its own development as well as the cooperation with other countries in a multitude of areas has repeatedly demonstrated the importance of international cooperation rather than confrontation to achieve its goals. Space exploration and space research are definitely of global nature, demanding the establishment of worldwide cooperation [3,5,6] and are therefore perfect fields of interest, where Europe can show and further its capabilities as a space power in the world.

Significant statements supporting international cooperation in space and Earth science and space exploration have been expressed during the 50th anniversary commemorations of the International Academy of Astronautics [7–10]. European main stakeholders for space activities (e.g. European Union, ESA, national space organizations and industry) – are becoming increasingly aware of the need to pursue a credible, joint strategy that must result in a coordination mechanism on international relations. It naturally stems that this strategy must also aim at strengthening the existing European leadership in the respective fields. In the context of the fourth objective, "enabling European research in support of international space partnerships", major initiatives are increasingly becoming global endeavours as the cost involved goes much beyond the resources available to any single space-faring nation. Prominent examples are robotic and human exploration of the solar system, as well as facing the challenges of climate change, as given below in further detail.

2.1. Exploration of the Earth–Moon–Mars space

Advancing robotic and human space exploration endeavours require challenging multifaceted missions and often multinational cooperation. All major space-faring nations are currently engaging in space missions that target the Moon, Mars and/or Near-Earth objects (NEOs), the environment "where humans can go".

The Moon represents a window through which we are able to explore the origin of our solar system as well as the dynamic of the Earth–Moon system. The Moon has been visited recently by orbiters from the US, Europe, Japan, India and China that obtained data with unprecedented resolution leading to important new discoveries, e.g. the presence of water on the Moon [5]. The search for extinct or extant life on Mars or organic material is one of the main goals of future surface missions developed during this decade, paving the way for returned samples and human exploration. NASA's successful multi-decadal Mars Programme of orbiters and rovers and Europe's MarsExpress spacecraft have given Mars a new face. With NASA's strategy to "follow the water" as well as detailed mapping of the surface mineralogy, excellent data on the evolutionary history and habitability of Mars have been revealed [11]. The current NASA rover "Curiosity" operating on the surface is sending back spectacular pictures. Near-Earth asteroids closely passing the Earth represent a potential threat to humankind and life on Earth, as recently witnessed by the Chelyabinsk meteor. However, apart from that, these objects also hold clues to the understanding of the early solar system and the impact history of early Earth. Their close proximity makes them interesting targets for the exploration of raw materials and supporting interplanetary journeys. The Japanese asteroid sample return mission Hayabusa has achieved an absolute first by bringing back a sample from the asteroid Itokawa in 2010 [12].

Despite the reduction in funding for space research the coming decade still promises to deliver interesting science data from missions that are currently in operation or development [6]. New Moon exploration orbiters and landers that will launch in this decade are developed by China (Chang'E programme), Japan (SELENE programme) and Russia/India (Luna Resource programme). NASA's "Mars Atmosphere and Volatile EvolutioN" (MAVEN) spacecraft scheduled for launch in late 2013 will investigate the Mars exosphere, and NASA's mission "Interior Exploration using Seismic Investigations, Geodesy and Heat Transport" (InSight) with a scheduled launch in 2016, will probe the early geological evolution of Mars.

A long-term ESA–Roscosmos cooperation plan for the exploration of Mars, ExoMars with two missions in 2016 and 2018, has been recently developed; these missions will investigate the atmosphere and the surface of Mars for signs of habitability and life and prepare for the Mars Sample Return mission. A second Japanese NEO sample return mission Hayabusa-2 is planned for launch in 2014. NASA's New Frontiers programme will launch the "Origins Spectral Interpretation Resource Identification Security Regolith Explorer" spacecraft (OSIRIS-Rex) mission to an asteroid in 2016.

Many of the past, current and future missions are/will be conducted in international cooperation through the provision of instruments, bilateral agreements and international science data exploitation. However, none of them are truly multi-national. And none of the space exploration missions described above is truly led by Europe. For the joint European/Russian ExoMars programme the essential elements such as launcher and Entry Descent and Landing (EDL) technology is provided by Russia. Europe's involvement in Mars sample return architectures on international level has not yet materialized.

As emphasized by the SAG in 2010 an essential element of a coordinated international space research programme should be the exploration of Mars [13]. A comprehensive Robotic Mars-Exploration Programme, performed in cooperation with major non-European space-faring nations should include robotic surface missions related to the habitability of Mars, ground-based analogue studies [14], as well as return missions with Martian samples. The SAG 2012 recommendations [4] propose that Europe should also engage in international research programmes in the area of impact hazard and mitigation of NEOs. Furthermore the development of exploration and technological concepts for NEO probes and sample return missions and technology enabling participation in international efforts of Moon exploration were recommended.

The SAG 2012 recommendations state specifically that Europe must define its role within those global space programmes and prepare to contribute its key competences and systems. Among them are the Columbus Module and the Automated Transfer Vehicle (ATV). Europe has gained key competences for developing habitats and research laboratories in space. Autonomous planetary missions such as MarsExpress, VenusExpress and Rosetta have demonstrated Europe's excellence. In order to remain a strong partner in future international space exploration endeavours of this kind it is crucial that Europe develops key technologies (such as Entry Descent and Landing and Sample Return Systems), infrastructure for the curation of returned samples as well as specific instrumentation (e.g. for life

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