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COMMISSION STAFF WORKING DOCUMENT

A Role for Europe within a Global Space Exploration Endeavour

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Note: This document is proposed by the European Commission and the ESA Executive and has no financial implications.

1. Introduction

Europe, meaning the European Union (EU), the European Space Agency (ESA), and their respective individual Member States, has a long experience and deep expertise in human spaceflight and robotic space exploration activities to various destinations pushing the frontiers of knowledge done by its constituency or in cooperation with international partners. Article II of its Convention confers to ESA to *"provide for and to promote […] cooperation among European States in space research and technology…"*. Article 189 of the Treaty of Lisbon (Treaty on the functioning of the European Union) confers on the Union a shared space competence and in particular the capability to coordinate actions in the field of space exploration[1].
Furthermore, at the eighth Space Council in December 2011, European ministers invited in the Council Resolution *"the European Commission, ESA and Member States to pursue discussions at European level and with international partners with a view to defining a strategy beyond 2020…"*. Europe has also developed a strategic approach to enhance and focus EU international cooperation in research and innovation[2], and security, safety and sustainability of all outer space activities. Europe is therefore committed to develop a common European space exploration strategy building on existing and new international partnerships.

Space exploration is a political endeavour and a grand challenge of the century. It is a catalyst for the emergence of new technologies, scientific results and innovation that, as history shows, have significantly improved the safety and quality of life on Earth delivering value across all economic areas. Space exploration bears also a significant potential of inspiration and motivation for the younger generations and European citizens in general. It contributes moreover to building long-term strategic partnerships between countries. Space exploration provides thus undisputable benefits to actors involved, and in particular to their citizens. In addition to bringing innovation and economic development, space exploration has also an inherent cultural value as it addresses fundamental questions of humankind linked to the origin and existence of life in the universe as well as the limits of human life.

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1 *To promote scientific and technical progress, industrial competitiveness and the implementation of its policies, the Union shall draw up a European space policy. To this end, it may promote joint initiatives, support research and technological development and coordinate the efforts needed for the exploration and exploitation of space.*

2 Communication from the Commission on "Enhancing and focusing EU international cooperation in research and innovation: A strategic approach" adopted on 14 September 2012. Accessible at http://ec.europa.eu/research/iscp/pdf/com_2012_497_communication_from_commission_to_inst_en.pdf

2. Evolving international space exploration context

Established and new space-faring powers are developing novel and enhanced capabilities required for the exploration of various destinations while other countries are also eager to participate in this endeavour leading to an internationalisation of space exploration activities. International cooperation will undoubtedly be a pillar of future ventures. It will allow implementing a long sequence of projects to different destinations.

In this evolving context a shared vision for future space exploration agreed at political level has however not yet emerged because of different views among those countries or groups of countries developing space exploration plans and of different cost-benefit considerations. The time has come to develop a shared space exploration vision and identify concrete steps to guide short-term investments.

3. Drivers of the European vision for space exploration

The European vision and overarching goal of space exploration is underpinned by the following guiding principles:

– Science: Europe should seek to assure its long-term significant participation in the future exploration of the Solar System, by contributing to a robust international programme of missions driven by scientific objectives agreed by the largest research community.

– Technology, innovation and economic development: Europe's exploration ambitions should aim at long-term technology targets, to strengthen space technology and industrial base as well as to foster innovative applications that can improve the daily life of citizens and create economic opportunities for European companies and SMEs.

– Education and inspiration: Europe's participation in the global exploration initiative should be capable to inspire the younger generations to pursue Science, Technology, Engineering and Mathematics (STEM) careers.

– International cooperation and global partnership: Europe should ensure a long-term engagement as a competent partner in an international exploration initiative commensurate with its status as a global player.

– Human expansion: Europe would seek to assess conditions for a sustainable human presence in the Solar System.

The vision of Europe's activities in space exploration is to:

Explore space with robots and humans as a unifying and inspirational societal undertaking providing benefits to citizens.

The goal of Europe's involvement in space exploration is to:

Constantly generate knowledge as a source of scientific advance, innovation and economic progress as well as inspiration and cultural development.

4. Pillars of the European space exploration strategy

Member States, the European Space Agency and the EU, have already made significant contributions to human spaceflight and to robotic space exploration; they have demonstrated strengths on which Europe can build further.

The tenets of the European space exploration strategy encompass the following main pillars: enabling technologies, space transportation, space infrastructures and robotic missions[3], and a solid research agenda and portfolio of space exploration activities to different destinations (i.e. Low-Earth Orbit (LEO), Moon, Asteroids and Mars). The European space exploration strategy is based on an optimised and dynamic balance between robotic and human spaceflight activities, and between European missions and missions within a global plan building on existing activities and plans of European stakeholders.

(a) Research agenda for space exploration

Building on the past and current European activities linked to exploration, a cross-disciplinary research agenda for space exploration should be developed by the EU, ESA and Member States in consultation with all stakeholders from institutions, space agencies, research institutes, universities and industries. This should determine the current state of knowledge and build on objectives already agreed by existing scientific and technical forums such as the Committee on Space Research (COSPAR), the European Science Foundation (ESF), the International Lunar Exploration Working Group (ILEWG) the International Mars Exploration Working Group (IMEWG), the International Space Exploration Coordination Group (ISECG) and others to identify European science priorities. It may form the basis of a comprehensive European strategy for space exploration to guide missions, and support research programmes and technology developments. This comprehensive European research agenda for space exploration would be revisited periodically and be benchmarked against results.

(b) Technologies

Technology developments are a key enabler of any space exploration venture and space exploration has constantly been at the forefront of technological challenges. The EU, ESA, and Member States must have a strong R&D programme on enabling technologies. Technological priorities for Europe covering the whole spectrum of space exploration activities have been identified in several EU-ESA workshops organised in 2010 with key stakeholders, and in the Resolution of the seventh Space Council:

- automation and robotics;

[3] Seventh Space Council Resolution "Global challenges: taking full benefit of European space systems" adopted on 25 November 2010. Accessible at http://register.consilium.europa.eu/pdf/en/10/st16/st16864.en10.pdf

- novel energy production and storage (including nuclear);
- advanced propulsion;
- life support systems.

Priority areas for contribution to Europe's future exploration missions should be linked further to public policies promoting sustainable economic growth and benefits for the citizens. Europe should also bridge space and non-space sectors, to promote increased spill-over effects, as well as attract and support new actors, including small and medium enterprises (SMEs). In this context, dedicated technology "demonstrator projects" could be defined in selected areas of interests.

(c) Human space exploration

Manned LEO infrastructures and operations born from competition in the Cold War era have evolved into an international cooperation initiative, namely the International Space Station (ISS) which has become a living example of international collaboration. ISS is the current cornerstone of European activities in human spaceflight. With its assembly now complete, and with several years of operations ahead until 2020 and possibly beyond, ISS should be used to the fullest extent for optimising and broadening the scientific, technological and operational return and be further used as a test-bed for the preparation of future ventures as well as for enabling overall scientific progress. Research conducted on board ISS has already resulted in some concrete achievements directly relevant to society. The ISS is thus a significant step for European human space exploration activities. Europe has also to ensure sustained and cost efficient access to LEO infrastructures for its user community; and to take timely necessary actions for ensuring continuity. Participation in early human missions beyond LEO could be critical for the preparation of a human mission to Mars.

(d) Robotic space exploration

Robotic missions to the Moon, asteroids and Mars, including sample return missions, advance priority science objectives, demonstrate technologies and play an important role in reducing risks for future human missions by acquiring knowledge and testing technologies. The ExoMars programme in cooperation with Russia and the United States is the current priority for Europe. It should be followed by the implementation of a series of robotic missions (autonomously or in cooperation with international partners) at a regular and resilient pace preparing for an international Mars Sample Return (MSR) mission, that would also be an important precursor for a future human mission. These missions would allow to build-up technological capabilities and scientific knowledge supporting future long-term international exploration objectives.

(e) Transportation for space exploration

Secure, reliable and affordable access to space, orbital transportation and re-entry from space are critical for space activities, including exploration. Advances in transportation capabilities are key to enabling sustained space exploration. Europe will continue to play a critical role in this domain recognising its long heritage and strong assets in space transportation and access to LEO, such as Vega, the Ariane launchers family and the Automated Transfer Vehicles

(ATVs). The recent decision on the initiation of the NASA-ESA cooperation on the Multi-Purpose Crew Vehicle Service Module (MPCV-SM) is an example of Europe's capability to play a significant role in this domain. Furthermore, international cooperation is a sound and cost effective way to ensure more resilient space transportation architecture to and beyond LEO. Future international space exploration ventures should thus avoid needlessly duplicating space transportation capabilities. A common space transportation policy at international level which aims, firstly, to ensure a resilient and cost-effective access for cargo and humans to LEO and beyond; and secondly, to realise the necessary standardisation of interfaces (e.g. such as IBDM), would therefore be an enabler for a successful global exploration endeavour. Europe is keen to promote the development of such a policy.

5. The European space exploration strategy

A clear European vision and position on space exploration is the basis for engaging with other partners. The European contribution to a, yet to be agreed upon, global scenario must however have an evolution potential, being technologically innovative, and benefit from the legacy of the previous European achievements and heritage (e.g. robotic exploration missions to the Moon and Mars, scientific missions to the Solar system, Vega, Ariane launchers, ATVs, ISS Columbus module, flights of European astronauts, and research in microgravity and in atmospheric re-entry). Europe's contributions to a shared vision, compatible with European resources, must also be visible, strong, strategic, ambitious and based on useful objectives and clear benefits.

Financial resources for human space exploration have been, and are expected to remain, limited in Europe for the foreseeable future. This is however also the case for many space-faring countries. As a consequence Europe will not participate with a leading role in a variety of activities in space exploration, and particularly in human spaceflight. On the other hand, the European legacy on scientific and robotic missions should be recognised and Europe can take a leading position in some future robotic missions.

On the basis of the evolving international context and Europe's involvement in space exploration with its on-going and planned programmes, the European space exploration strategy builds on a stepwise approach, focusing on different activities and multiple destinations (i.e. LEO, Moon, Asteroids and Mars) over time (short-term milestones within a long-term and flexible approach) open to international partnerships with partners having the similar ambitions or complementary capabilities.

Human exploration of Mars is considered today as the long-term goal of European and international exploration plans, with LEO, the Moon and asteroids being possible important short and medium-range destinations en route to the "Red Planet". As outlined in the 2011 Food for Thought paper, the current European long-term scenario, consistent with international plans, could build on the following sequence:

- 1st step, 2015-2020: utilisation of the ISS, robotic missions (including ExoMars), R&D for preparing the next step, and demonstration of human transportation capabilities;

– 2nd step, 2020-2030: continued robotic missions including Mars Sample Return, human missions beyond low Earth orbit, R&D for preparing the next step;

– 3rd step, >2030: sophisticated robotic missions in the Solar System, continued human exploration missions, including possibly human missions to Mars.

The European space exploration strategy is thus made up of three major phases building on cornerstone robotic and human missions and activities and the development of a robust set of exploration technologies, coordinated among the different programmes of ESA, Member States and the EU.

6. Way forward

Space exploration is an area of great interest for the EU and Europe as a whole. It is committed to remain a major actor in the field to foster scientific progress, to gain new knowledge, to further sustain innovation and economic development, to address planetary challenges and opportunities, and to develop and strengthen international partnerships. The International Space Exploration Forum (ISEF) is an excellent opportunity to explore new avenues for collaboration that should contribute towards the broad European space exploration strategy described in Section 5.

Without prejudice to any large scale projects existing or that may result from the ISEF meeting, a pragmatic, step-by-step approach aiming to facilitate initiating concrete international cooperation ventures building on technology "demonstrator projects" is proposed by one or more actors and linked to exploration missions and an overall vision. These demonstrator projects would target key enabling technologies for space exploration, e.g. on robotics, energy, propulsion or life support that are major building blocks of future space exploration activities. Actors interested to participate to such demonstrator projects could form clusters, which would meet and discuss how to build such projects, including governance, technical appraisal, costing aspects and possible funding arrangements. Concrete results and further steps may be presented at the next ISEF meeting.