

The Aurora Programme

Europe's Framework for
Space Exploration



Piero Messina

HME Liaison Office, Directorate for Human Spaceflight, Microgravity and Exploration Programmes, ESA Headquarters, Paris, France

Bruno Gardini

Aurora Exploration Programme Manager, Directorate for Human Spaceflight, Microgravity and Exploration Programmes, ESA/ESTEC, Noordwijk, The Netherlands

Daniel Sacotte

Director of Human Spaceflight, Microgravity and Exploration Programmes, ESA/ESTEC, Noordwijk, The Netherlands

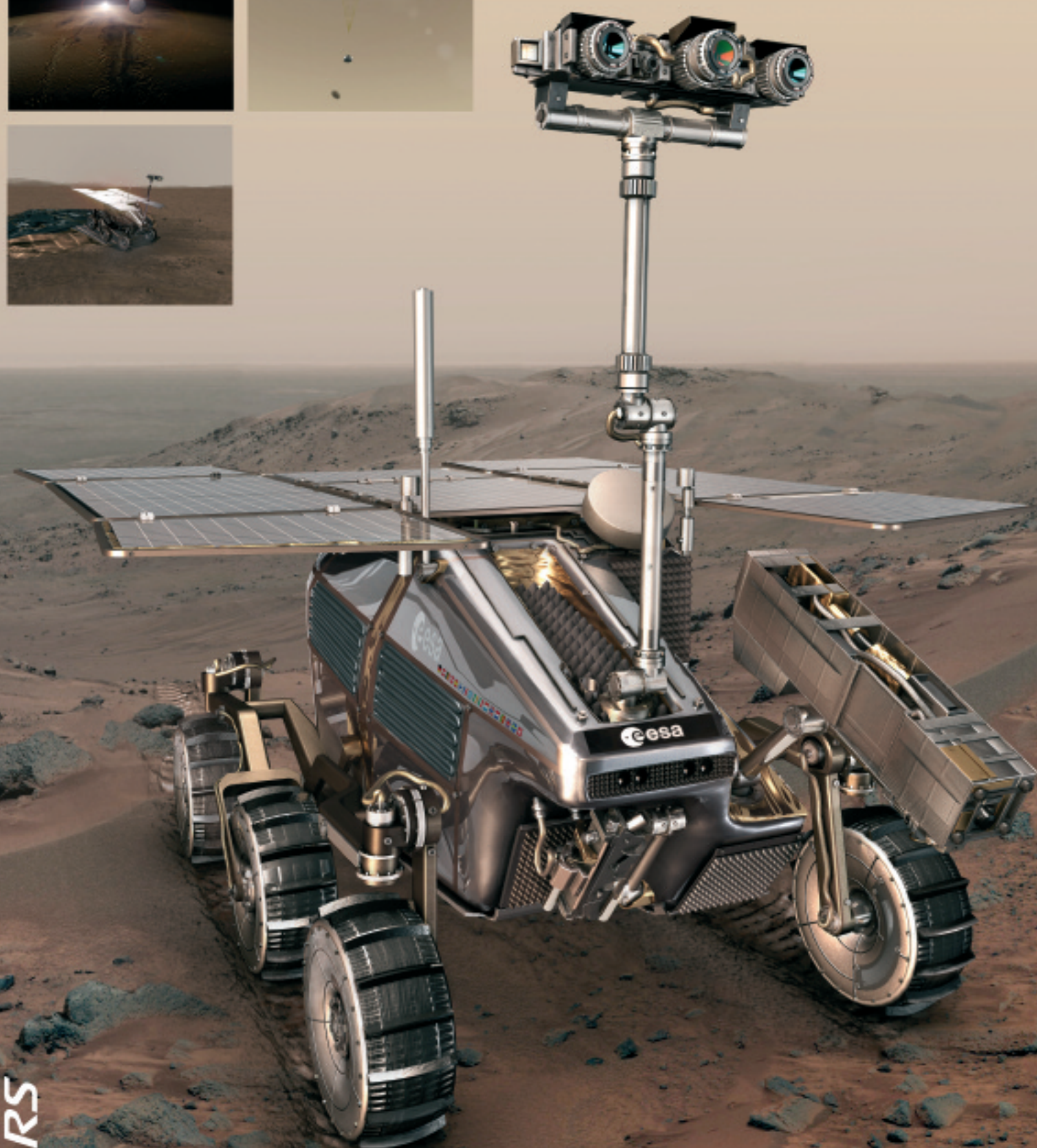
Simona Di Pippo

Chair, HME Programme Board; Director, Exploration of the Universe, Italian Space Agency (ASI)

By 2001, ESA had identified robotic and human exploration of the Solar System as one of the major undertakings for Europe and its international partners in the 21st century. Spacefaring nations, with Europe at the forefront, have successfully explored other planets through unmanned missions, and the International Space Station is a permanent presence in low Earth orbit. Creating the framework that brings together the robotic and human elements of space activities for further exploration of the Solar System is the next logical step.

The Aurora Programme Preparatory Phase

The scientific, academic and industrial communities were polled on the preferred destinations and objectives of a potential long-term exploration programme. Mars scored first, followed by other destinations that included the Moon. The advice from the different communities was an important element in proposing a new European programme – the Aurora Space Exploration Programme – as a building block in a broader international effort for the robotic and human exploration of Mars, with the Moon as an important stepping stone.



EXOMARS



Search for traces of past and present life
Characterise geochemistry and water distribution
Improve environment and geophysics knowledge
Identify biological hazards to future missions



The Preparatory Phase lasted from the beginning of 2002 to December 2005, with the number of participating countries growing along with the funding. From the initial €14 million, the envelope reached more than €48 million from 12 States (Austria, Belgium, Canada, France, Germany, Italy, The Netherlands, Portugal, Spain, Sweden, Switzerland and the UK). Italy was the main contributor.

In January 2004, the US President announced a new space policy directing NASA to implement the *Vision for Space Exploration*. This was a turning point in global space policy, creating a renewed interest in space exploration among spacefaring nations. An assessment on how far this new policy would affect Europe's exploration programme was conducted in cooperation with European space agencies, industry and other stakeholders gathered in the Space Exploration Policy Assessment Group. At the same time, a thorough revision of the ExoMars mission and its scientific objectives was performed with the scientific community and the national delegations.

The long-term and visionary nature of space exploration requires well-rooted support by society at large. This is why a dialogue with stakeholders and with sectors not usually involved in space was conducted throughout 2005. The aim was to identify the main elements that should drive Europe's sustained involvement in space exploration with its international partners. At the end of the consultations, four main drivers were identified:

Europeans in space: allowing Europe to be a significant partner in exploration by assuring access to enabling technologies, the presence of European culture in future space endeavours, the enhancement of European integration, and the creation of European pride around an inspiring and ambitious cooperative project;

Habitability and life beyond Earth: increasing our knowledge of life, its evolution and its environment;

Sustainable human life in space: the development of enabling technologies to support life and protect health, to access energy, manage environmental risks and exploit local resources;

Sharing the space adventure and benefits: communicating the excitement of human spaceflight and exploration, and sharing the benefits with the general public.

On the basis of all the above, together with indications of support from Member States, an ambitious yet realistic proposal was prepared for the Aurora Space Exploration Programme and submitted to the ESA Council Meeting at Ministerial Level in Berlin (D) on 5–6 December 2005.

The Approved Aurora Programme

European Ministers confirmed, at the highest political level, the willingness of Europe to play a significant role in exploring and understanding the Solar System, in particular Mars and the Moon.

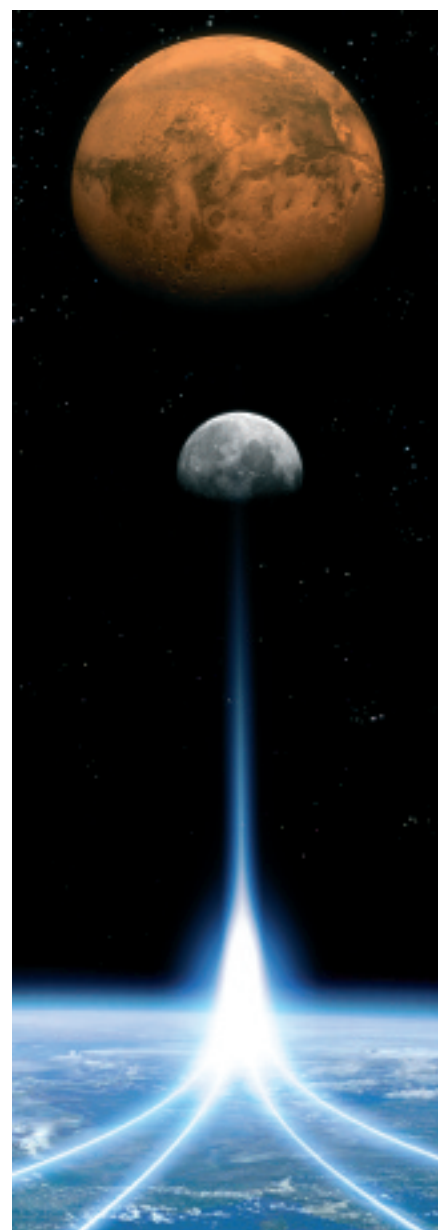
The approved Aurora Space Exploration Programme consists of two main elements: the Core Programme and Robotic Missions. The first is defining architectures and scenarios, and preparing for missions and their enabling technologies; the other is developing actual missions.

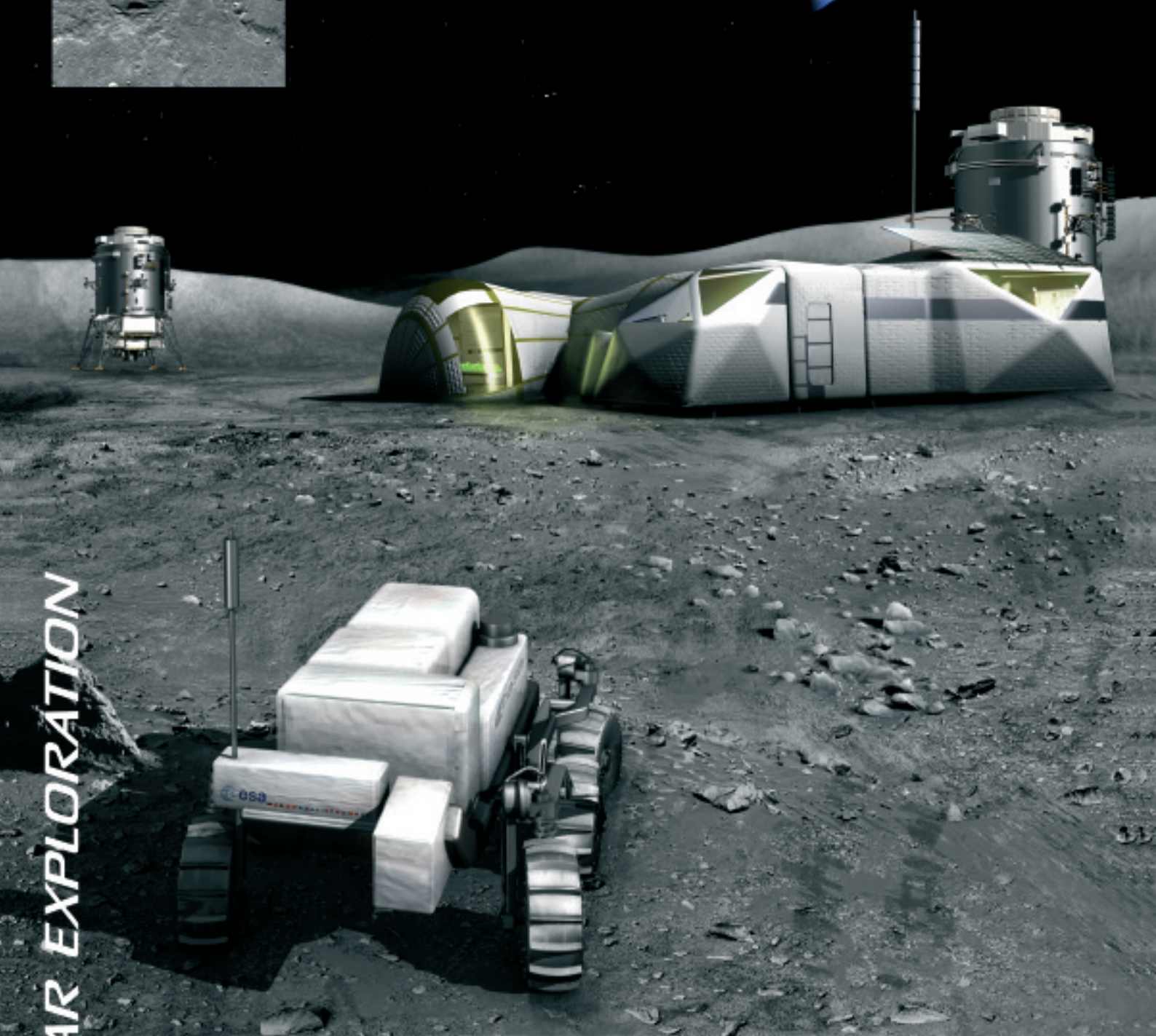
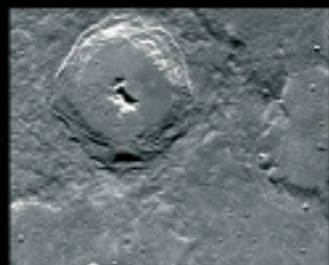
Core Programme

The Core Programme aims to allow Europe to participate meaningfully in the future exploration endeavours, although further decisions at later Ministerial Councils will be required. Based on a building-block approach, the activities will ensure the robustness of Europe's contribution, and include:

- exploration roadmaps, scenarios and architecture studies. Updating the scenarios and roadmaps elaborated during the previous Preparatory Phase, based on continuous consultations with the stakeholders and leading to system studies and mission architectures for human and robotic

missions to the Moon and Mars. These activities will enable Europe to determine its objectives, interests and priorities by identifying further missions and elements for realisation; – development of enabling technologies for Mars Sample Return (MSR). The goal of bringing back the first sample of Martian soil is a major technological challenge – and a great opportunity for the scientific world. It has important implications for understanding the planets, studying the origin of the Solar System, and





LUNAR EXPLORATION



General human and robotic exploration technology
Habitat and Inflatable Module Technologies
Robotic Crew Aids/Surface Robots
Life Support, Food Production, Waste Management



searching for life on Mars. MSR is also a major milestone for exploration because its mission profile is suitable for a subsequent human visit to Mars;

- development of general enabling technologies for exploration, flight demonstrations of selected enabling capabilities, and the preparation of potential European contributions to lunar exploration;
- awareness activities, in association with the European Union, to engage European citizens in space exploration and to inspire new generations through, among others, the involvement of universities in the elaboration of future exploration missions.

Robotic Missions

This component covers the development, launch and operation of selected exploration missions. The first proposed European mission is ExoMars – the first exobiology mission to the planet. Slated for launch in 2011, it will provide valuable experience in the design and operation of new enabling technologies and capabilities: the entry, descent and landing system, and the rover, drill and sample-acquisition systems. It will thus open the way to future scientific and exploration missions. At the same time, ExoMars will return excellent scientific information by searching for traces of past and present life, characterising the planet's biological environment, improving our knowledge of the Martian environment and geophysics, and identifying hazards before landing other spacecraft. ExoMars will qualify Europe to undertake future Mars exploration. The mission is described in greater detail in the following article.

At the Ministerial meeting in December 2005, Member States could subscribe to either or both elements: 14 of the 17 countries chose both. In particular, ExoMars received overwhelming support, especially by Italy. Subscriptions of more than €650 million exceeded the financial envelope required for the proposed baseline configuration. The Core

Programme attracted some €73 million for 2006–2009, with Belgium and Italy being the main contributors, followed by the UK and Switzerland.

Status and Next Steps

Phase-B1 of ExoMars is due to be completed by the end of 2006. Under the prime contractorship of Alcatel Alenia Space Italy (AAS-I), the phase has accommodated the outcome of the Ministerial Council. The baseline mission, launched by a Soyuz from Kourou in 2011, includes a carrier, a descent module, a rover and the scientific payloads: the exobiology 'Pasteur' on the rover and a geophysical package on the lander. Communications and data-relay will be provided by NASA's Mars Reconnaissance Orbiter, which arrived at the planet last March.

In order to increase mission robustness and capabilities – in anticipation of interest by Member States – two additional options are being studied in parallel by industry. An orbiter could be launched on a second Soyuz, or an Ariane-5 would allow the baseline's carrier to be replaced by an orbiter. Participating States will be called on to decide early next year at the Implementation Review. That meeting will also take into account the maturity of the mission concept.

A series of activities is being launched within the Core Programme, with special attention to architecture and system studies, a Mars Sample Return Phase-A2 study, and key technology developments for the next mission to Mars. In particular, the MSR mission is considered by the scientific community

worldwide as a logical step in the exploration of Mars. From a scientific point of view, it will provide samples of Martian soil to study in our laboratories, where instruments are far more powerful than could ever be carried by spacecraft or rovers. From a technology standpoint, the MSR mission would be the first attempt at a return trip to the Red Planet, with all its operational implications.

Conclusions

Aurora is Europe's framework, through ESA, for defining and developing the European contribution, be it capabilities, building blocks or autonomous missions, to the global endeavour of the robotic and human exploration of the Moon and Mars. Europe's ambition is to work out a comprehensive, long-term exploration strategy, building in a degree of independence alongside significant commonality with NASA's and other partners' plans. Europe is seeking to be a key partner, building on its achievements and experience in robotic, scientific and planetary missions, infrastructure development and human spaceflight. ESA's planned robotic missions are fully in line with the internationally agreed strategy for the scientific exploration of Mars. They fit nicely in terms of timing and scientific goals with other missions to Mars. In an evolving international context, it is important that the European contribution is robust and sustainable and, to the maximum extent possible, does not critically depend on a single partner's capabilities. Since Aurora's inception, international cooperation has always been identified as a key enabling element to achieve the long-term goals. Sound, yet flexible, international cooperation is therefore an important element for sustainability and robustness in the worldwide endeavour in which Europe and ESA intend to play a significant role.



Further information on Aurora can be found at
www.esa.int/aurora