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The European space exploration programme: Current status of ESA's plans for Moon and Mars exploration

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Abstract

After a large consultation with the scientific and industrial communities in Europe, the Aurora Space Exploration Programme was unanimously approved at the European Space Agency (ESA) Council at ministerial level in Edinburgh in 2001. This marked the start of the programme's preparation phase that was due to finish by the end of 2004. Aurora features technology development robotic and crewed rehearsal missions aimed at preparing a human mission to Mars by 2033.

Due to the evolving context, both international and European, ESA has undertaken a review of the goals and approach of its exploration programme. While maintaining the main robotic missions that had been conceived during Aurora, the European Space Exploration Programme that is currently being proposed to the Aurora participating states and other ESA Member States has a reviewed approach and will feature a greater synergy with other ESA programmes.

The paper will present the process that led to the revision of ESA's plans in the field of exploration and will give the current status of the programme.

1. Introduction

Recent events have resulted in an increased attention for Mars and the future plans for space exploration, notably towards the Moon and the Red Planet. The successful operations of the two MERs by NASA and of the Mars Express orbiter by European Space Agency (ESA) have provided a wealth of data about our neighbouring planet. The even more recent findings where methane and water vapour seem to match have contributed to raise the expectations towards future robotic missions to Mars by the scientific community and beyond to the public at large.

Space exploration is not new for ESA. We pursue several missions in solar system exploration, such as Mars Express, the Europe's first Mars mission, SMART-1, a lunar probe (launched in 2003), Rosetta (launched in March 2004), Cassini/Huygens, a joint ESA–NASA mission to reach Saturn and Titan by the end of June. Europe is also planning the exploration of other solar system bodies, such as Venus with Venus Express (due for launch in 2005) and Mercury with BepiColombo, in cooperation with Japan.

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ESA is also a key partner in ISS (about 5.2 billion €) through the supply of many elements: the Columbus laboratory, the Automated Transfer Vehicle the Data Management System (DSM-R) and the European Robotic Arm. The participation of several European astronauts to ISS missions has allowed Europe to gain experience and competences in human spaceflights.

The ESA has been working since 2001 on establishing a roadmap for the exploration of those celestial bodies holding promise for traces of life, notably Mars. This was dubbed the Aurora Programme for the exploration of the solar system. The preparatory phase of this programme was unanimously voted at the ESA Council at ministerial level in Edinburgh in November 2001. The programme was conceived as an optional programme and it was subscribed by 10 ESA countries (including Canada). Its goal was to formulate first and then implement a European long-term plan for the robotic and human exploration of the solar system bodies, in particular those holding promise for traces of life. Within the Aurora Programme it was envisioned to establish a European framework for exploration and pursuing near and long-term priorities in order to prepare Europe to play a crucial role in the international endeavour aimed at the robotic and human exploration of Mars.

The programme was supported by an Exploration Programme Advisory Body including representatives from all main ESA's advisory bodies concerned with the solar system exploration as well as representatives from academia, industry and from the European Astronaut corps. An Aurora Board of Participants, with representatives from all subscribing nations, was also created. After discussion within these two bodies, study activities for two major robotic missions were approved and started.

2. Exomars

In 2009/2011, a mission to study the Martian environment and search for evidence of life, past or present, on the planet's cold, arid surface. The large spacecraft will take advantage of the planet's thin atmosphere to aerobrake into Mars orbit. Using an inflatable braking device or a parachute system, a descent module will then deliver a large rover to the Martian surface.

The autonomous roving vehicle, powered by conventional solar arrays, will spend many months exploring the hostile terrain. The 40 kg payload (known as *Pasteur*, after the famous French microbiologist) will include a drill and a sampling and handling device that will enable it to analyse soil from sites that may be hospitable to primitive Martian life forms.

The rover navigation system, including optical sensors, on board software and autonomous operation capability and the life detecting payload will be a significant technological challenge to European and Canadian industry. Testing of rendezvous and docking techniques on the ExoMars mission will prepare the way for the second flagship mission, Mars Sample Return.

A recently launched call for ideas for experiments to be included in the Pasteur payload has attracted a very large response with over 580 investigators from 30 countries having expressed the desire to participate in the ExoMars mission.

Several industrial teams, composed by European and Canadian companies, have been studying the different mission elements as well as the overall mission and everything is ready to start the next industrial phase.

3. Mars Sample Return

Scheduled for launch in 2011/2013, this mission will bring back the first sample of Martian soil for analysis in laboratories on Earth. After braking into Mars orbit, a descent module will be delivered to the planet's surface. A robotic 'scoop' will collect a soil sample and place it inside a small canister on the ascent vehicle.

This will then lift off from the surface and rendezvous with the spacecraft in Martian orbit. An Earth return vehicle will bring back the capsule and send it plummeting into the atmosphere. Slowed by a parachute or inflatable device, it will make a fairly gentle touchdown before the recovery teams retrieve the precious sample from the landing site.

Today, the main aim of the Mars Sample Return mission is to test at reduced scale technologies for return trip to Mars. The mission does not foresee mobility and sample collection is currently limited at 0.5 kg. Planetary protection (PP) is a critical issue for MSR both to avoid forward and backward contamination.