

AUTHOR: F. Casoli, Head, Space Sciences, Microgravity and Exploration Office
CNES, 2 place Maurice Quentin 75039 Paris, France.



Fig. 1

→ A high risk landing on Mars, the selection of the NASA mission INSIGHT for seismology on Mars, carrying a high-precision seismometer provided by a consortium led by France, the selection of the first large-sized (L1) and third medium-sized (M3) missions of ESA's Cosmic Vision program, and, in December 2013, the launch of ESA's emblematic astrometry mission, GAIA: no doubt, 2012 and 2013 were rich in events and highlights for Universe Sciences at CNES, at a programmatic level.

2012 was also marked by the end of scientific operations for two missions led by CNES, COROT and PICARD. Equally important, the harvest of scientific results was really significant. We can take two examples in 2013. The first scientific results obtained through Curiosity rover's instruments showed that Mars had indeed been habitable in a distant past, because evidence of freshwater lakes was discovered. Thanks to data obtained with the PLANCK mission, the content of the Universe in terms of dark matter and dark energy has been substantially revised. Besides, PLANCK's observations are confirming the standard inflationary model of the Big Bang.

As part of ESA's mandatory scientific program, the backbone of our scheduling, we can mention the ongoing missions MARS EXPRESS and VENUS EXPRESS, as well the continuation of the exploitation of observatories, such as SOHO, CLUSTER, XMM-NEWTON and INTEGRAL. PLANCK and HERSCHEL missions have come to an end and both satellites have been deactivated and put on a graveyard orbit. However data scientific exploitation and processing are still ongoing. HERSCHEL's observations showed that stars are born in gas and dust's filaments, which are organized by the turbulence caused by the propagation of shocks or waves in the interstellar medium. They also revealed an inflow of matter along these filaments. As for PLANCK, the first cosmological results were unveiled in Mars 2013 and were widely covered by French and international media, thus reflecting the impact on the general public of this mission with a strong French participation. Final data processing is still ongoing. It should give rise to a new series of publications in 2014.

ROSETTA woke up from space hibernation on January 20, 2014 and is still pursuing its long journey toward Comet Churyumov-Gerasimenko. CNES is pursuing the development of the ground segment of the astrometry mission GAIA, in partnership with a consortium of French laboratories. Given the large volume of data and the need to process them throughout the mission, CNES chose to develop technologies of the so-called "big data". Instrumental contributions to the BEPICOLOMBO mission are in the final stage of the development process. As for the Cosmic Vision program, SOLAR ORBITER's payload, the first medium-sized (M1) mission of this program, has now entered phase C. France widely contributed to five out of the ten instruments onboard (among which two at the co-PI level) and another is under the technical and scientific responsibility of CNES. The second medium-sized mission (M2) is the cosmological mission EUCLID, suggested by a vast European consortium and under French responsibility. SOLAR ORBITER should be launched in 2017 and EUCLID in 2020.

//// Cosmic Vision and Exploration of Mars

PLATO, the third medium-sized mission (M3), has also been selected in November 2013. It aims to detect telluric exoplanets in the habitable zone of their stars. French laboratories are making important technical and scientific contributions to this mission which should be launched in 2024. As for large-sized missions, the JUICE mission was selected as first mission (L1). It aims to study Jupiter and its satellites Europe, Callisto and Ganymede and will be launched



around 2022. Scientific themes were chosen for the next two missions: hot and energetic Universe for L2 (2028) and gravitational Universe for L3 (2034). The French scientific community has rallied to increase the French presence on these missions.

Exomars program consists in two missions in partnership with ROSCOSMOS, with the launch in 2016 of an orbiter, carrying a scientific payload to describe the Martian atmosphere, and an Entry, Descent and Landing Demonstrator Module (EDM), carrying a scientific payload to investigate the Martian environment. In 2018 a European and American rover will be launched by NASA and equipped with a scientific laboratory. Phase B on this Pasteur payload is continuing in France.

////// Multilateral program

In the framework of CNES's multilateral program, the COROT mission (Convection, ROTation et Transits planétaires – Convection ROTation and planetary Transits) has put an end to its scientific operations in late 2012 after a failure of some instruments. COROT had been launched on December 27, 2006 and had discovered 32 planetary systems and more than 150 potential exoplanets, early 2014. COROT's second objective was to study the inner structure of stars through asteroseismology. It discovered solar-like oscillations in red giants. COROT was withdrawn from service in June 2014 after a few technological experimentations. Final data processing and archiving is still ongoing.

As for fundamental physics, the atomic clock, PHARAO, is in its final stage of development, for a launch to the International Space Station (ISS) in 2016, in the framework of the Aces project. T2L2, a time transfer by laser link experiment, carried by JASON 2, has been in orbit for more than five years. More than twenty ground stations used T2L2 to carry out metrology experiments.

PICARD, a microsatellite from the Myriad series, was launched on June 15, 2010 and withdrawn from service on April 4, 2014. Scientific exploitation is still ongoing and provided interesting

results about ultraviolet solar variability and Sun flattening. Another microsatellite, TARANIS, which aims to study very high-energy phenomena between Earth atmosphere, thermosphere and ionosphere has entered Phase C and will be launched in 2016, as well as MICROSCOPE, which aims to test the Principle of Equivalence with a very high accuracy, in cooperation with ESA and DLR.

As for Mars Science Laboratory, after its high risk landing on Mars on August 6, 2012, Curiosity Rover is heading for the Mount Sharp (Aeolis Mons). France widely contributed to two instruments, ChemCam and SAM, and both of them largely contributed to the first series of scientific results published in late 2013. ChemCam is one of the most used instruments, having fired more than 100 000 laser shots. It is under co-responsibility of French and American laboratories and is operated every two weeks from the FIMOC center at the Toulouse space center. French scientists can also program SAM's operations from there.

For Mars again, NASA selected in August 2012, the twelfth mission of its *Discovery* program: INSIGHT (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport), aiming to understand the evolution of telluric planets' formation, by investigating the inner structure and the processes at work on Mars. INSIGHT will be launched in Mars 2016.

[Fig. 1]
The Structural and Thermal Model of the BepiColombo Mercury Transfer Module in the Large Space Simulator at ESA's test centre in the Netherlands. The image was taken on 20 February 2013 ahead of a 12-day Sun-simulation test that began 26 February.
© ESA

[Fig. 2]
Marco Polo
© NASA