MICROGRAVITY SCIENCES - SCIENCES EN MICROPESANTEUR

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Fig. 1

The International Space Station (ISS), parabolic flights, automated capsules and sounding rockets, not to mention prolonged bed rests: these are just some of the tools used by scientists doing research on microgravity.

Indeed, while physicists investigating material see space as a laboratory for the study of complex phenomena, in the absence of gravity, it is also essential to understand the physico-chemical phenomena involved in space systems themselves, to ensure that they operate correctly.

Life sciences in microgravity and space medicine are beginning to discern the conditions necessary for life in the hostile space environment, as well as the role of gravity in the development and functioning of living organisms.

CNES is providing financial and organizational support in many areas, either by directly funding the French scientific community, in the framework of ESA programs such as the European Program for Life and Physical Sciences in Space *(ELIPS)* or through cooperation with key partners such as the USA, Russia, Japan and China.

At the Toulouse Space Center, the Center for the development of microgravity applications and space operations (CADMOS) monitors many scientific and technical space experiments undertaken during manned flights (Fig. 2).

Finally, each year, French scientists conduct over twenty experiments during parabolic flights on the NOVESPACE Airbus A300 ZERO-G, either during the two annual flight campaigns funded by CNES or the two ESA campaigns.

As for the International Space Station (ISS, Fig. 3), the European program of unmanned resupply spacecraft, ATV (Automated Transfer Vehicle), was successful, with the launch of the third and fourth ATVs: Edoardo Amaldi in 2012 and Albert Einstein (Fig. 1) in 2013. The fifth and last ATV, known as George Lemaître, will be launched in July 2014. Each of these cargo ships supplied the space station with more than 6.6 tonnes of fuel, water, food and equipment.

The presence of six-person crews enables greater use of the International Space Station (ISS) for scientific experiments, with, for condensed-matter physics, the operation of the DEvice for the study of Critical LIquids and Crystallization (DECLIC) instrument's three inserts. The three of them were used in space and then brought back to Earth to be modified so they could help answer new scientific issues and finally re-sent on board the ISS.

Scientists studied phenomena such as the solidification of transparent materials and the boiling crisis. French scientists also used two laboratories dedicated to the study of materials (MSL) and fluid physics (FSL), with for instance experiments on foam.

Still on the ISS, teams are pursuing various experiments in biology and human physiology, with for instance the CARDIOMED equipment dedicated to medical monitoring of astronauts, in partnership with Russia. Other bilateral projects include the development of the CARDIOSPACE instrument with China, dedicated to cardiovascular monitoring of Chinese astronauts and to be launched early 2015.

With Russia, the space capsule BION carried in spring 2013 numerous French experiments, especially a cardiovascular monitoring experiment on mice, the MTB experiment (Mice Telemetry in BION). Finally, an ambitious bed rest program was carried out at the MEDES (Institute for space medicine and physiology) in Toulouse, with three campaigns – each one of them lasted three weeks – with twelve participants, to test various countermeasures.

Fig. 2

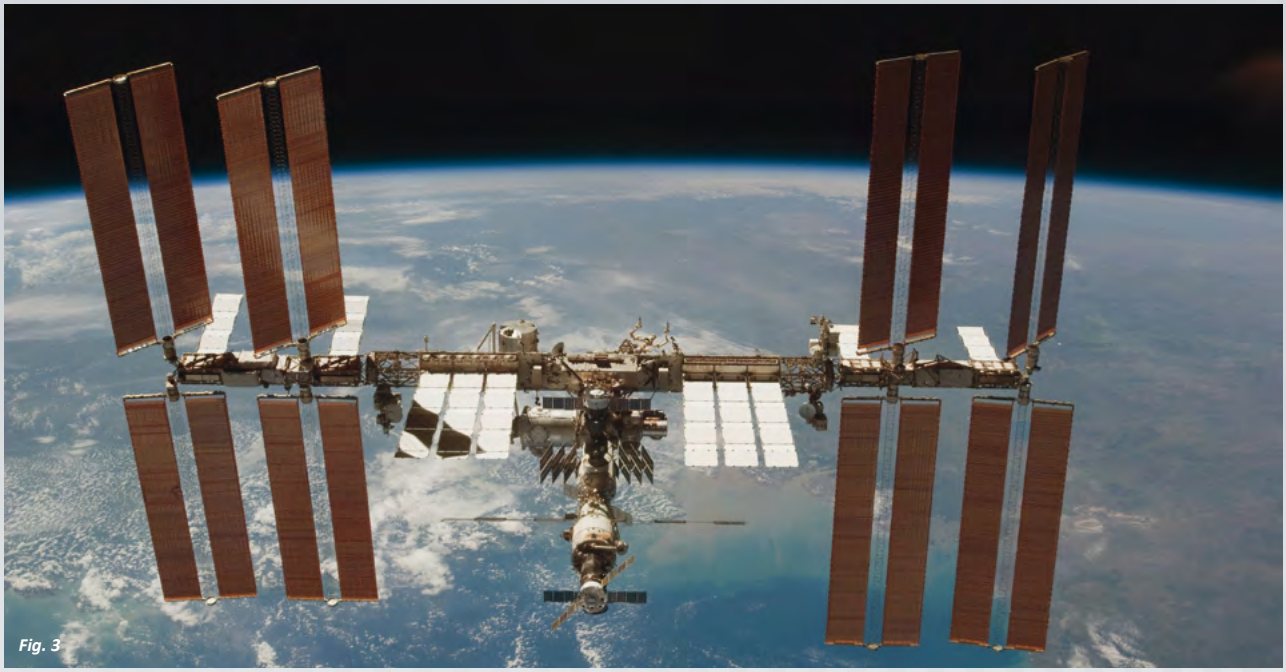

Fig. 3

[Fig. 1]
Undocking of the ATV 4 Albert Einstein from the International Space Station on October 28, 2013.
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[Fig. 2]
DECLIC operations in CADMOS in Toulouse: this image shows two operators who can visualize what happens in the insert and send commands to the facility in real time.
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[Fig. 3]
The International Space Station photographed by a member of the STS-130 mission onboard the space shuttle Endeavour undocking from the station.
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