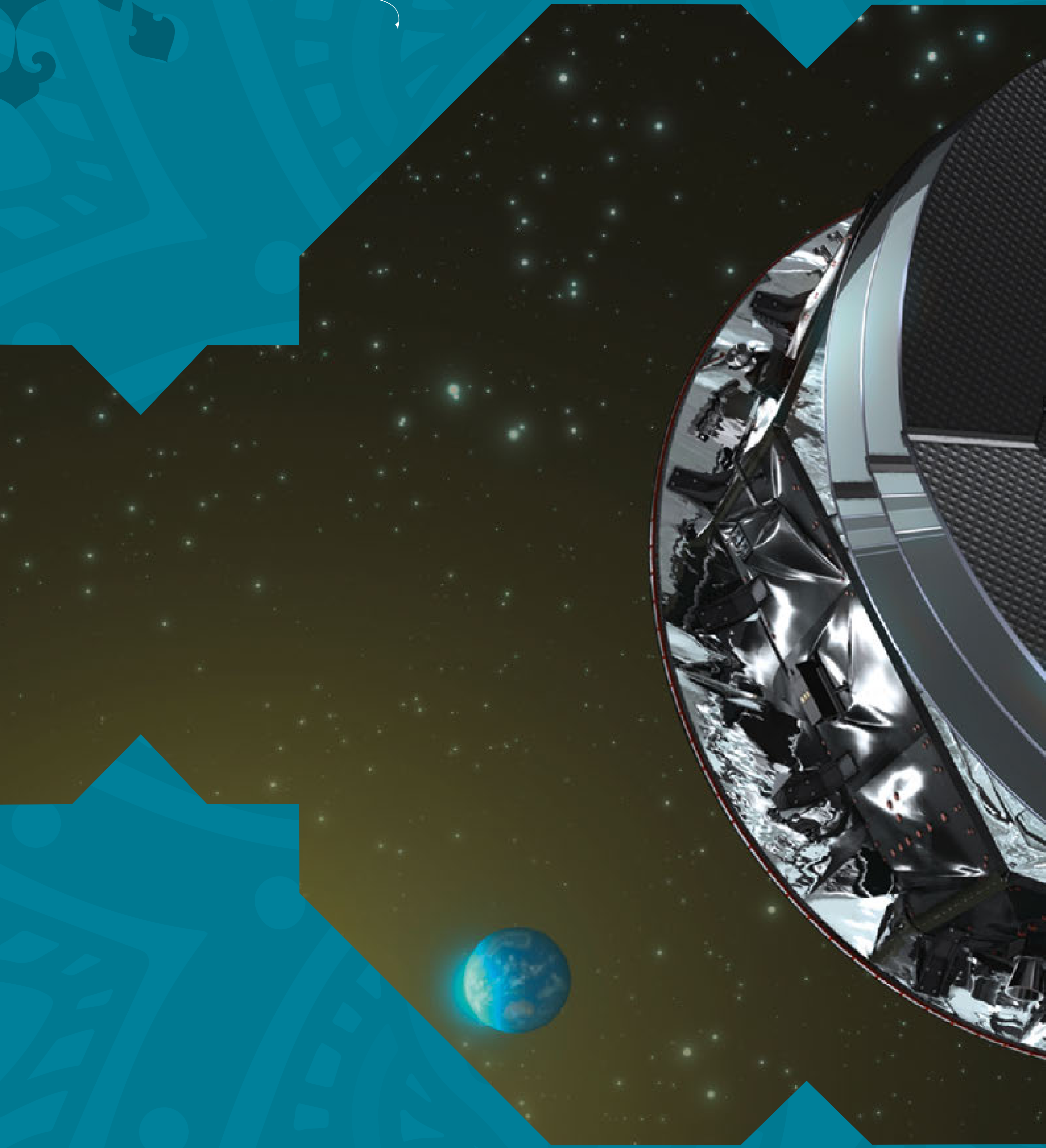
Cospar 2016



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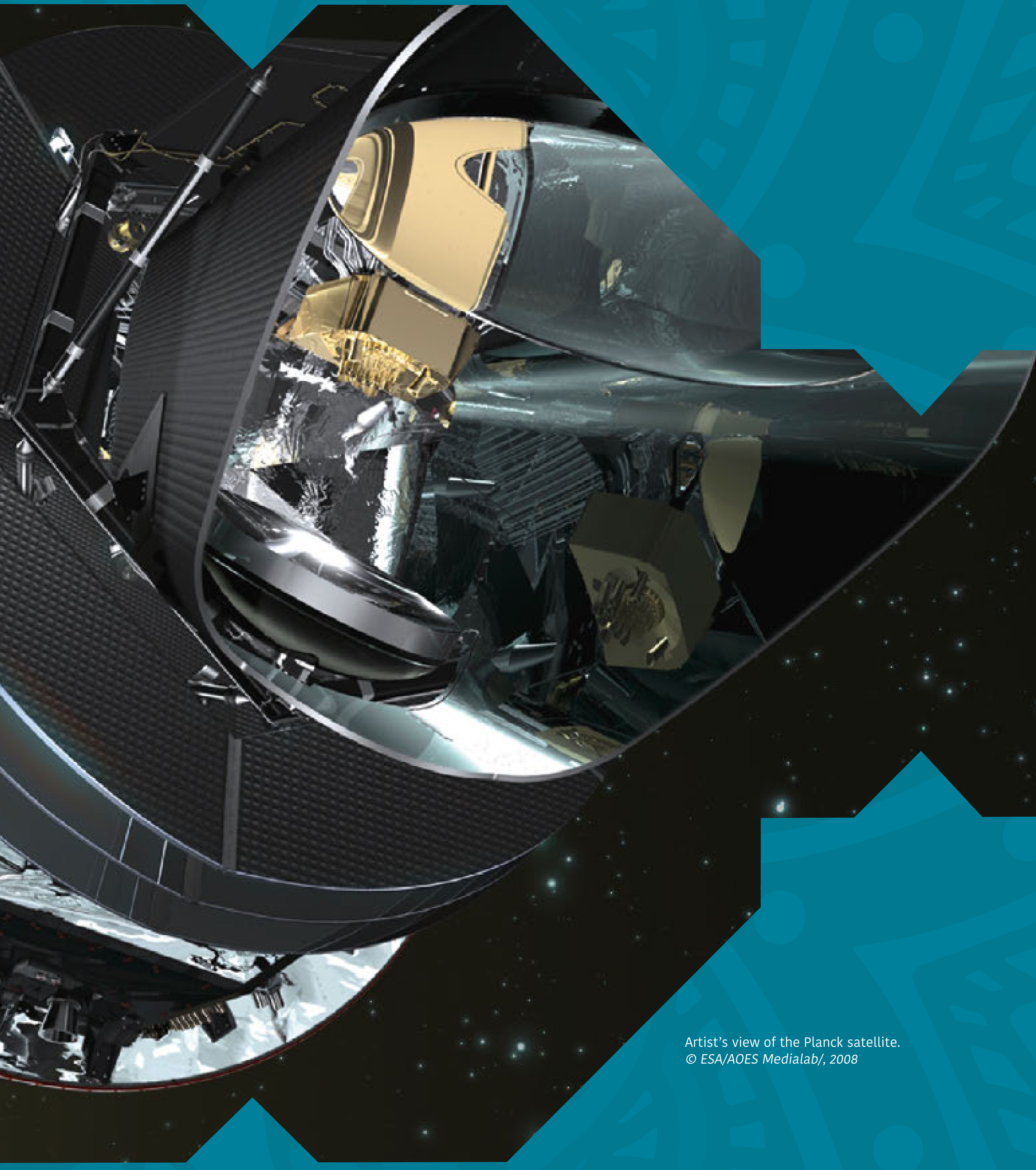

Artist's view of the Planck satellite.
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Space Sciences

CNES supports the research of the French community in all space-related fields, from the study of the Solar System to the distant Universe, as well as unprecedented experiments in Condensed-Matter Physics and Human Physiology under microgravity.

Thanks to the involvement of CNES in a wide range of fast-paced missions as part of ESA's Cosmic Vision program, French scientists have become leaders of or are strongly associated with these missions. In 2014, ESA selected ATHENA as its second large-class mission (L2), whose X-IFU an instrument built by an international consortium led by CNES and a French laboratory. In 2015, ESA's Space Science Advisory Committee (SSAC) chose three missions among 10 to be considered for the medium-class mission (M4). CNES strongly supports two of these projects – ARIEL will study exoplanets and THOR will be dedicated to the microphysics of solar plasma. The final selection will take place in mid-2017. In spring 2016, ESA will issue an invitation to tender for the upcoming medium-class mission (M5). CNES will guide and support French projects.

On the multilateral front, the SUPERCAM instrument was selected in 2014 to be launched to Mars in 2020 aboard CURIOSITY's successor.

Shortly after the last COSPAR, PHILAE landed on the Tchouri comet on November 12, 2014. During this worldwide event and for the first time in history, the 100-kg little robot put on a comet various instruments, many of which had been built by French laboratories supported by CNES. Contact with PHILAE was lost and made again, and 80% of the scientific program on the ground has been completed. When COSPAR 2016 is held, the mission will be close to its end, and ROSETTA will join PHILAE a few months later by landing on the comet. Besides the discovery of a new world thanks to images of breathtaking precision, the results of this mission – including the discovery of molecular oxygen and a detailed investigation of the internal structure of a comet nucleus – are unprecedented and have been the subject of publications in the most prestigious journals.

In 2014, the JUICE mission was adopted and HAYABUSA 2 was launched toward an asteroid, carrying a lander including a French instrument. The same year, GAIA started the first measurements of a billion stars in total; it is likely to go further than initially planned, up to m = 21.

In Fundamental Physics, 2016 will go down in history due to the announcement of the detection of gravitational waves predicted by Einstein exactly 100 years ago. This announcement occurs at the right time to validate ESA's bet: on December 3, 2015, it launched the LISA PathFinder mission aimed at testing the technologies required for the large space-based gravitational-wave observatory, known as LISA, with arms of more than one million kilometers in length. This historic opening of a new observation window on our Universe is likely to lead to new unsuspected discoveries. CNES and the French laboratories are participating in this adventure. Still on the topic of general relativity, the microscope satellite assembled at CNES was launched in April 2016. It will test the equivalence principle at an incredible level of precision – 100 times better than before. Once again, the French community will spearhead this exciting field of physics.

Microgravity and Exploration

CNES provides many ways of addressing these issues – parabolic flights lasting 20 seconds, automatic flights up to 30 days and flights up to one year in the space station. In 2015, CNES subsidiary Novespace inaugurated its new Airbus A310 microgravity aircraft.

In 2014, ESA selected the first French astronaut in six years for a six-month flight aboard the space station. The departure is scheduled for November 2016 with more than 60 experiments, including seven funded by CNES. Low Earth orbit access is the first step of the exploration ladder which may bring man to Mars.

By sending astronauts into orbit, the physiology work supported by CNES has three purposes. They are: to understand the living (fundamental aspects), to support man in space (operational aspects) and to help medicine solve daily medical problems (with societal applications). The fundamental aspects are addressed with societal applications when the evolutionary constraints of gravity are suppressed. The operational aspects deal with assessing the risks on astronauts' health and performance (physiology, radiation-induced biological effects and psychological effects of confinement). Establishing an appropriate life-support system and preparing the assistance to and return of astronauts are also essential. Finally, effective counter-measures must be studied and implemented.

Additional ground-based space equipment gives access to microgravity analogs (bedrest) and confinement. MEDES and CADMOS are irreplaceable tools to conduct this research on cardiovascular deconditioning and muscle immune response loss. The many years of work on the study of metabolic adaptations to microgravity showed that physical inactivity is a primary cause of most modern chronic metabolic diseases. The development of a device remotely controlled in the ISS from CADMOS (tele-ultrasound) suggests the possibility of remote diagnosis for astronauts in orbit as well as for high-level medicine in remote areas. This illustrates the strong impact of research in microgravity medicine upon societal applications.

In Condensed-Matter Physics, access to microgravity, especially via the DECLIC instrument provided by CNES on the ISS, suppresses the constraint of gravity and answers fundamental, technological and societal questions on the properties of the states of matter – solid, liquid and gas. By eliminating convection, sedimentation and hydrostatic pressure, microgravity reveals physical regimes that are usually hidden by these effects. These studies could affect critical fluids, crystal solidification and growth, complex fluids, some biological objects, combustion and two-phase flows. The study of supercritical fluids may have significant consequences and applications linked to organic and hazardous waste elimination. In another field, solidification in microgravity improves our understanding of the mechanisms at work in metallurgy, and produces very homogeneous samples that are beyond reach on the ground. As to granular regimes, microgravity allows to observe the transition between a spatially homogeneous fluidized state (gas) and a particle cluster when density increases. The study of pure water foam and of the dynamics of red blood cells in the bloodstream is also possible. Last but not least, the study of combustion dynamics enhances our ability to work on space flight safety.