ITALIAN REPORT

To the 41st COSPAR Scientific Assembly

PRESS

Aa.Vv.
Italian Report to the 41st COSPAR Scientific Assembly

Graphic design & layout: Davide Coero Borga
Managing editor: Pietro Ubertini

Images credits: ASDC, ASI, ESA, ESO, INAF, JPL, NASA
Cover credits: Andrea Cellarius

ISBN 978-88-98985-01-2

ITALIAN REPORT

To the 41st COSPAR Scientific Assembly

INAF PRESS

INDEX

Benvenuti

Foreword

Pietro Ubertini, Italian National Committee Delegate to COSPAR.

The Italian Report of the 41st COSPAR General Assembly is designed by the National Institute for Astrophysics (INAF), which supports COSPAR's activities, with the collaboration of the Italian Space Agency (ASI) and other stakeholders playing a major role in the Italian scientific space programs. This Report summarizes two years (2015-2016) of science space activity in Italy and the aim is to provide the relevant information in a snapshot, giving at the same time a full overview of the current Italian space research programs. The Report is divided in seven scientific commissions: Space Studies of the Earth's Surface, Meteorology and Climate (A); Space Studies of the Earth-Moon System, Planets, and Small Bodies of the Solar System (B); Space Studies of the Upper Atmospheres of the Earth and Planets Including Reference Atmospheres (C); Space Plasmas in the Solar System, Including Planetary Magnetospheres (D); Research in Astrophysics from Space (E); Life Sciences as Related to Space (F); Materials Sciences in Space, and Fundamental Physics in Space (H).

The main research programs revolve around the observation of the Universe including cosmology, planetary science, fundamental physics, Earth observation, climate and meteorology, life science in space, and space related new technologies. Relevant contributions are provided by the national research bodies (INAF, CNR, INFN, etc.), which propose space programs, missions, satellites and observatories in different research fields. The majority of the Italian scientific space programs are carried out in the framework of the European Space Agency (ESA) funding, via the mandatory and optional programs. Italy has also a well-consolidated partnership with NASA, but also with Russian, Chinese, and Japan space agencies and other international space organizations. Italy is playing a major role in the European Space Agency (ESA) Cosmic Vision program, participating in the next large mission to Mercury, BepiColombo (launch planned 2018), Small mission for exoplanet search, CHEOPS (2018), Medium size missions M1-Solar Orbiter (2018), M2-Euclid (2020), and M3-PLATO (2024). The Italian community is also committed to the exploitation of the ESA first Large mission L1-JUICE (2022), to the Jupiter's icy moons, as well as L2-ATHENA (2028), to study the hot and energetic Universe, and in the forthcoming Gravitational Wave Observatory (2034). Italy participates to the EXOMARS program, a scientific exploration mission lead by ASI to bring a rover to Mars, which is a joint venture between Italy, ESA and Russia. Italy contributes to the Chinese-Italian satellite CSES Seismo-Electromagnetic Satellite (2017), designed to monitor electromagnetic field and waves, plasma and particles perturbations of the atmosphere, ionosphere and magnetosphere induced by natural sources and anthropocentric emitters, and to study their correlations with the occurrence of seismic events.

After the 2014 COSPAR's report, Italy has been celebrating its 50 years of scientific space exploration: the San Marco 1 satellite was launched by an Italian team using an American Scout rocket from Wallops Flight Facility, Virginia, US on December 15, 1964. The successful experiment re-entered the atmosphere on September 13, 1965. Since then, the Italian scientific and industrial community has continued its path toward space exploration building up on the achieved success, investing in space programmes and cooperation with other countries pushing to the extremes our frontier of knowledge.

Italy as a global player

Nicolò D'Amico, president of the Italian National Institute for Astrophysics.

The National Institute for Astrophysics (INAF) has a peculiarity comparing to other astronomical research institutions around the world, because INAF covers all the branches of modern astronomy. Nowadays, the modern astronomy is extremely specialized, but at the same time major studies are addressed by a multi wavelength approach. That being said, a single national Institute covering all the branches of modern astronomy has a great potential. INAF is organized into seventeen *Research Structures* spread throughout Italy, each one representing a "center of cost". A few of the *Structures* have a relatively narrow imprinting related to the management of major national facilities, but the majority of *Structures* has multidisciplinary skills. This includes several technological projects related to the development of new instruments and techniques, which are carried out keeping an authoritative eye to a systematic transfer of knowledge towards the national industry. We own and manage the National Telescope Galileo (TNG) at the Canary Islands; we are members of the Large Binocular Telescope (LBT) Foundation in Arizona; we own and manage three radio telescopes involved in the European VLVBI Network (EVN); Italy is member of the European Southern Observatory since 1982, and INAF President is the Italian representative in ESO Council.
Furthermore, INAF directly supports the design and construction of one most challenging telescope ever conceived so far: the "European Extremely Large Telescope" (E-ELT) and is also involved in the Cherenkov Telescope Array (CTA) project, hosting the headquarters of the CTA Organization in Bologna (Italy). We are also involved in the Square Kilometer Array project, and we are leading the political negotiations to transform the SKA Organisation in an Intergovernmental Organization (IGO).
INAF is deeply engaged into outreach activities: it owns and manages several Visitor Centers and organizes public conferences and didactic activities for schools.
Of course INAF is also involved in space astronomy and space science activities, and the information provided in this report prove that the involvement is massive, covering almost all the fields of space research.
We have a solid collaboration with the Italian Space Agency (ASI) and we are proud to be involved, through rather competitive selections, into several space missions of the European Space Agency (ESA) and NASA. The Italian Government has recently allocated significant resources to the National Plan for Research (PNR), in which space research has a prominent role, so we can safely predict a strong engagement of our Institute into the future of space research.
I am proud to read the present report and I am grateful to Pietro Ubertini - one of the most outstanding scientists in this field - for the effort.

ABCDEFGHIJKL

Scientific Commission

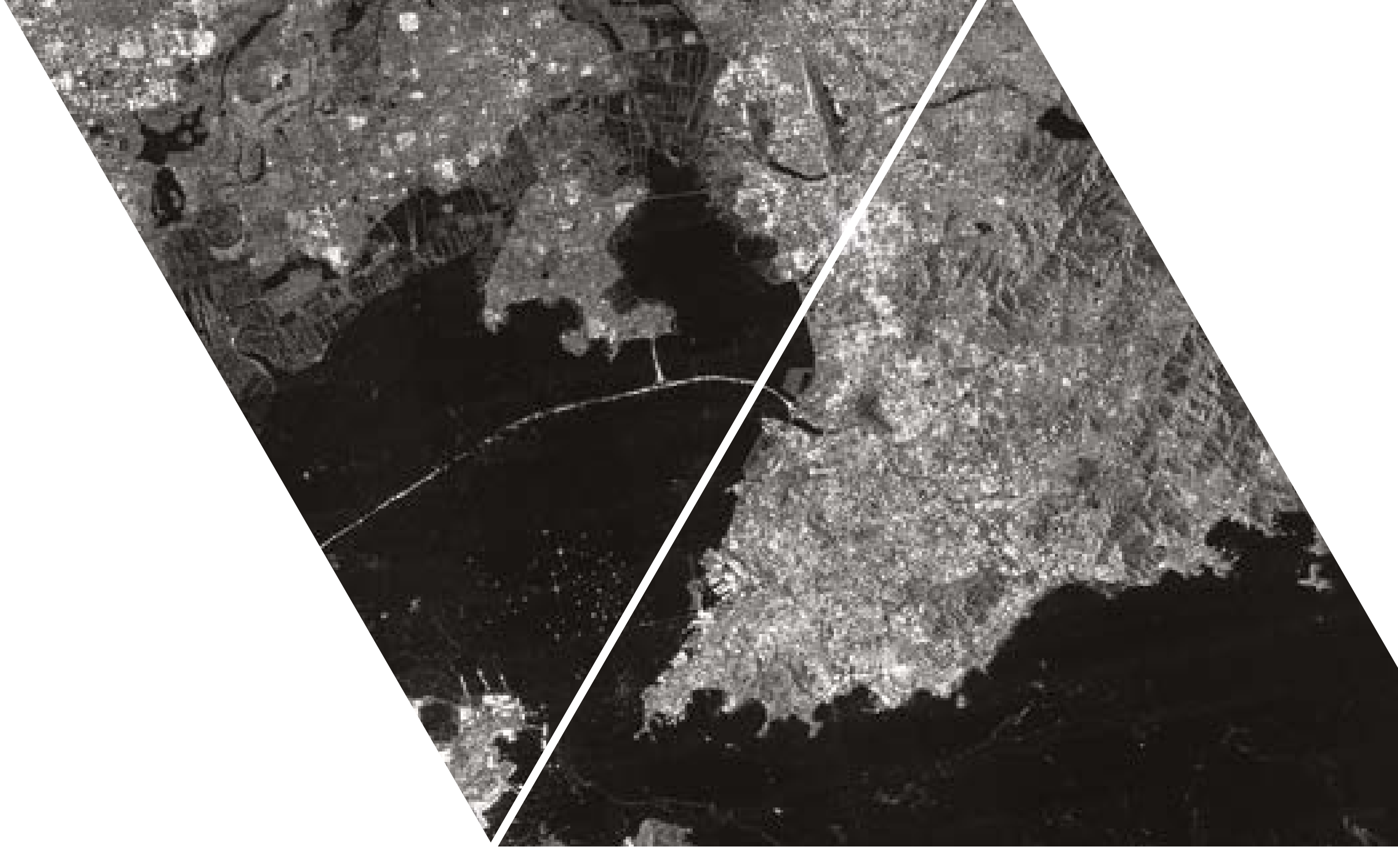
COSMO Sky-Med

The COSMO-SkyMed system is a constellation of four radar satellites for Earth Observation founded by the Italian Space Agency and the Italian Ministry of Defense.

COSMO-SkyMed is at the forefront of technology and uses high-resolution radar sensors to observe the Earth day and night, regardless of weather conditions. The constellation is fully operational since the 2008.
Its purpose is to monitor the Earth for the sake of emergency prevention (management of environmental risks), strategy (defense and security), scientific and commercial purposes, providing data on a global scale to support a variety of applications among which risk management, environment protection, natural resources exploration, land management, defense and security.
The constellation consists of 4 medium-size satellites, each one equipped with a microwave high-resolution synthetic aperture radar (SAR) operating in X-band, having ~600 km single side access ground area, orbiting in a sun-synchronous orbit at ~620km height over the Earth surface, with the capability to change attitude in order to acquire images at both right and left side of the satellite ground track (nominal acquisition is right looking mode).
The Ground Segment is responsible for managing the constellation and granting ad-hoc services for collection, archiving and delivery of products to the users.

Environmental disasters

Data and products supplied by the COSMO-SkyMed System represent a valid and important instrument, to carry on studies about causes and phenomena preceding environmental disasters as well as to improve the monitoring and evaluation of damages in case, for examples, of landslips, flood, earthquakes and volcanic eruptions. Observation within a specific area can be made during day or night and even in case of clouds, thus allowing to evaluate superficial alterations of the territory



and providing institutions in charge of managing the risk with a new and useful instrument of prevention and control. Furthermore, the system represents a precious help for sea traffic control.

Oceans and seacoasts
COSMO-SkyMed satellites can provide continuous and accurate information about conditions of seacoasts, seas and inland waters, so as to evaluate phenomena of coast erosion and pollution.

Agricultural and forest resources
COSMO-SkyMed satellites are capable to use – both to transmit and to receipt – horizontally and vertically polarized signals. This skill strengthens the possibility to classify soils as well as to monitor cultures during their phase of growth. Of particular interest is the possibility to monitor forests, which destruction has a strong impact on the quality of air and on earth resources.

Buildings
The high geometric accuracy of COSMO-SkyMed images as well as its space and temporal high resolution are incisive instruments for monitoring new settlements or soil and subsoil collapses, which are usually considered as the main cause of framework downfalls.

Cartography
Images supplied by the COSMO-SkyMed system may allow a new high resolution technical and thematic cartography and the accomplishment of a deeply accurate soil three-dimensional digital model for various applications.

GOCE

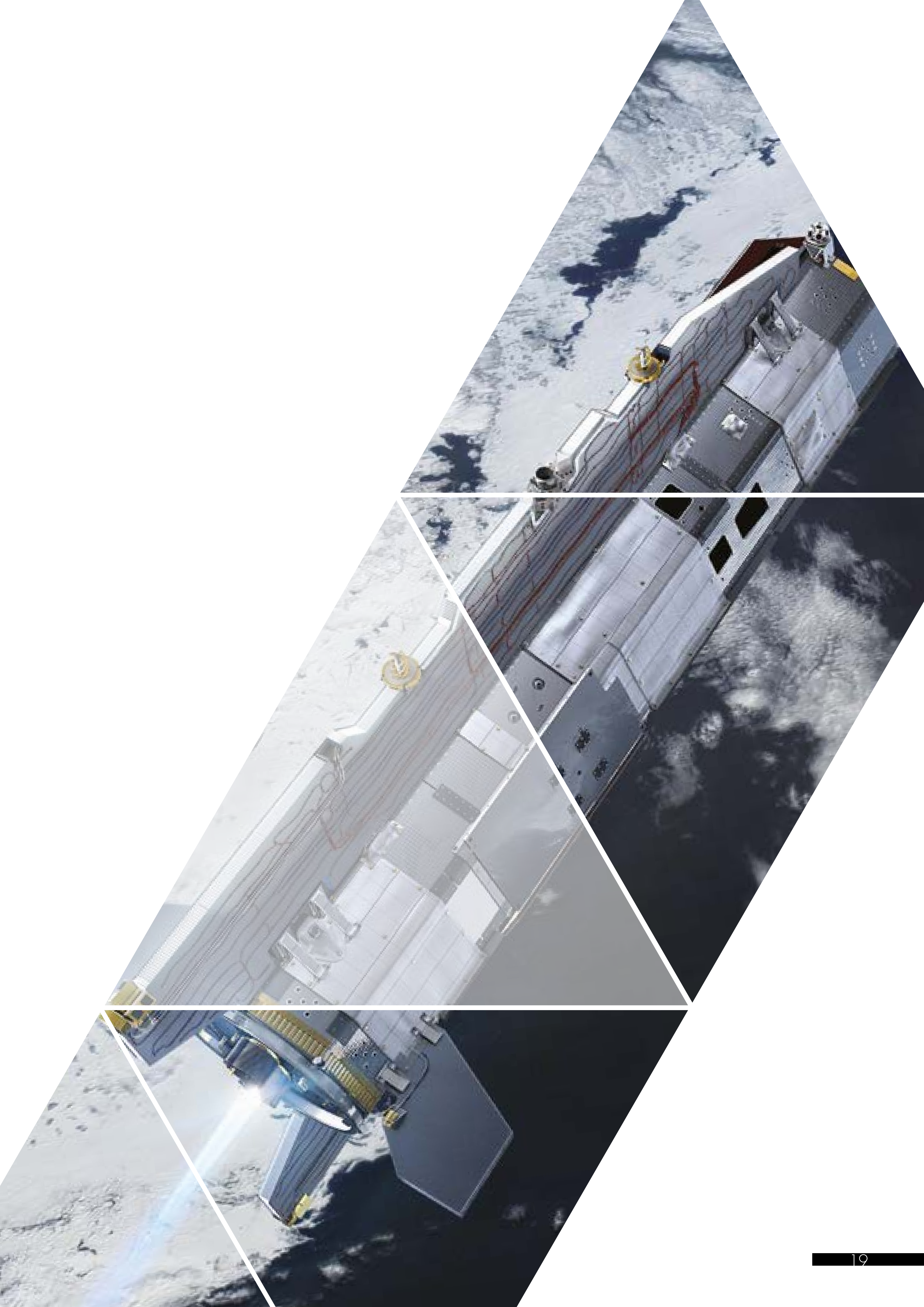
Gravity field and steady-state Ocean Circulation Explorer is a mission devoted to measuring the Earth gravitational field.

GOCE mission has been the first ESA Earth Explorer mission in orbit. Italy, has contributed to the satellite construction through Thales Alenia. Moreover, Politecnico of Milan has been a fundamental part of the Consortium called HPF (High Level Processing Facility) which has the task of transforming the satellite data into the estimation of the Earth gravity field. Finally, ASI has funded the GOCE-ITALY project that has enabled the investigation of the GOCE data by the Italian scientists. GOCE payloads are: the Electrostatic Gravity Gradiometer (EGG) and the Satellite to Satellite Tracking Instrument (SSTI), based on precise GPS receiver.

PRISMA

Earth Observation system with innovative, electro-optical instrumentation that combine a hyperspectral sensor with a medium-resolution panchromatic camera.

PRISMA (PRecursore IperSpettrale della Missione Applicativa - Hyperspectral Precursor of the Application Mission) is an earth observation satellite for monitoring of natural resources and atmospheric characteristics (information on land cover and crop status, pollution quality of inland waters, status of coastal zones and the Mediterranean Sea, soil mixture and carbon cycle). PRISMA combines an innovative hyperspectral camera (~ 250 bands in the range 400-2500 nm) with a panchromatic (0.4 - 0.7 μm) medium-resolution camera.



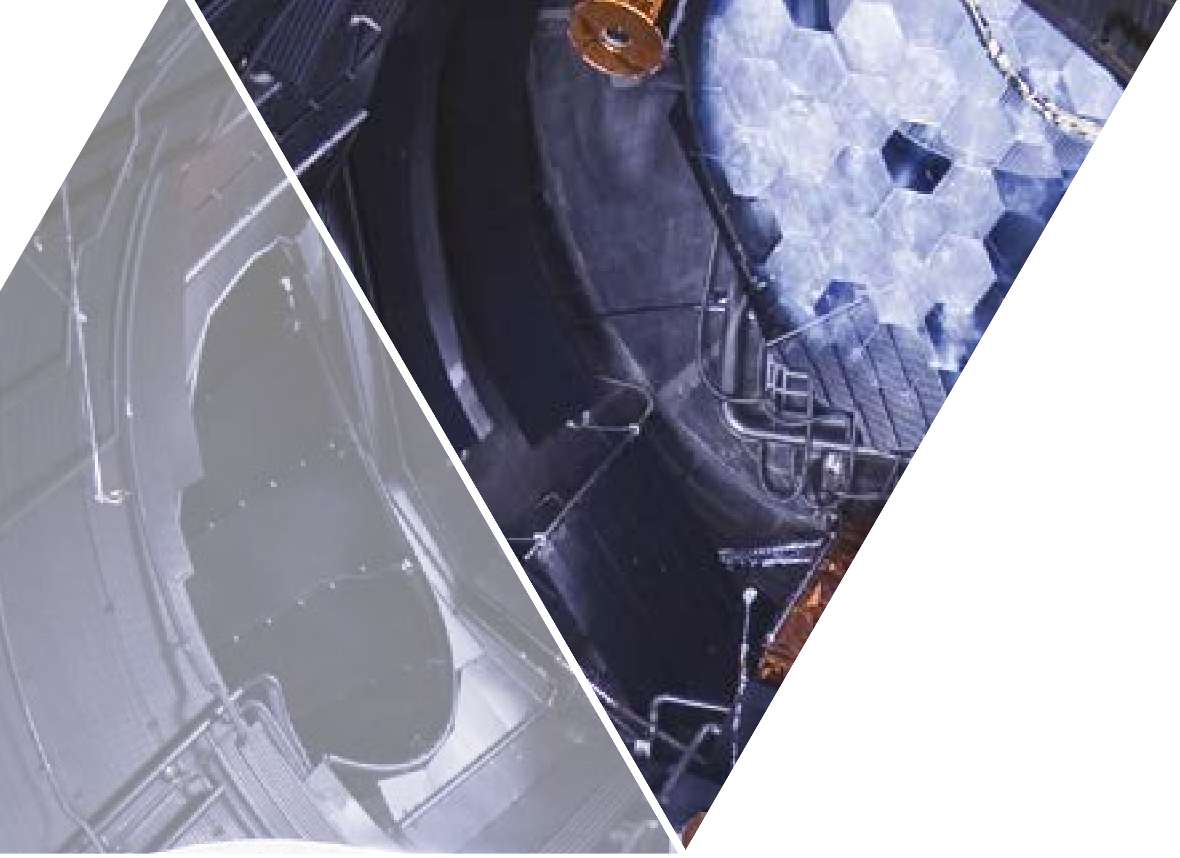
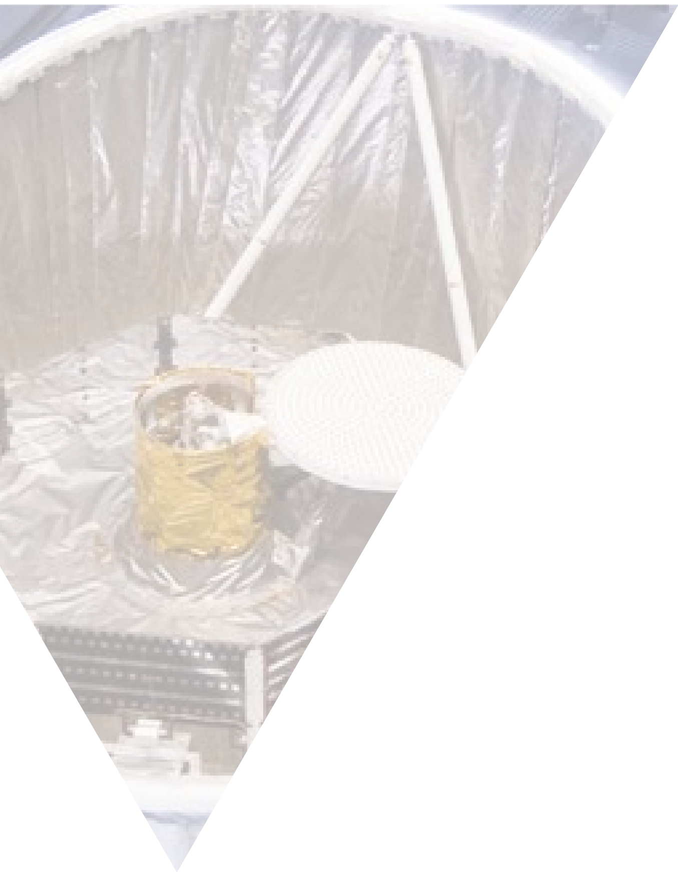
ABCDEFGHIJKL

Scientific Commission

BepiColombo

BepiColombo is an ESA/JAXA mission devoted to the exploration of Mercury and to fundamental physics quests. It is composed by two spacecrafts: MMO and MPO. It will be launched in the 2018 arriving at Mercury at the end of 2024. Italy is contributing with four instruments: ISA, MORE, SERENA, SIMBIO-SYS.

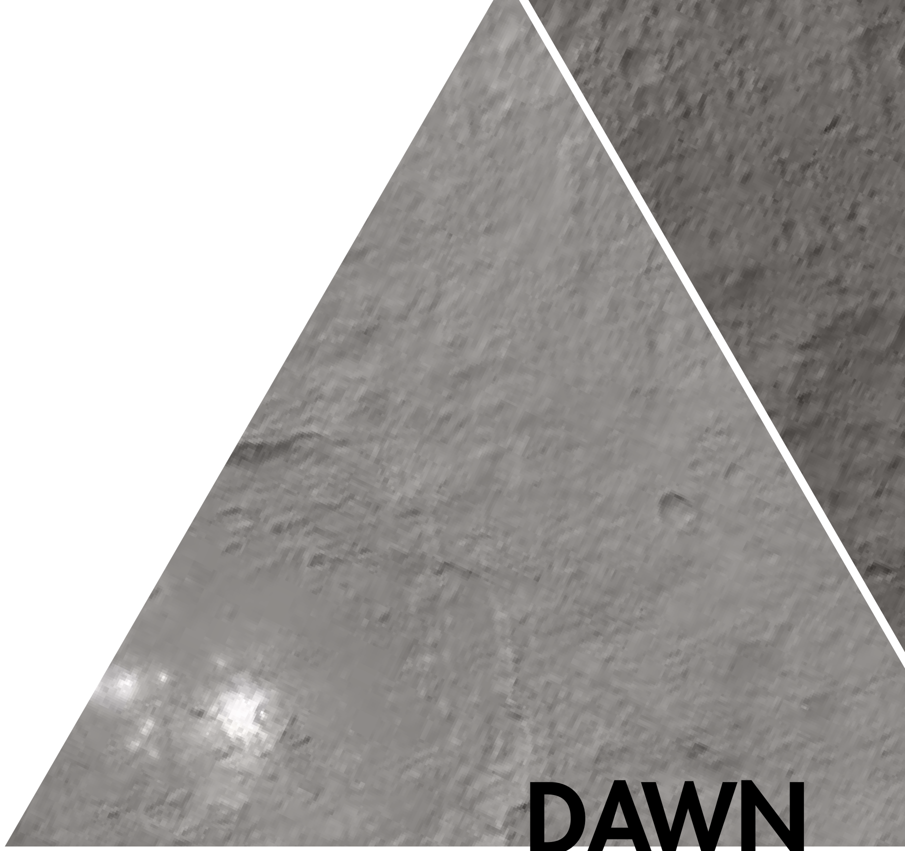
The BepiColombo mission represents the cornerstone n.5 of the ESA and the name is due to prof. Giuseppe Colombo that discovered the spin-orbit resonance between Mercury and the Sun.
The BepiColombo mission is composed by two modules: the Mercury Planetary Orbiter (MPO) and the Mercury Magnetospheric Orbiter (MMO).
In MPO, 11 european instruments are integrated. The main scientific objectives are related to the surface and composition of Mercury, to its internal structure and environment and to the test of Einstein's theory of General Relativity.
The MMO includes 10 sensors realized and integrated in Japan by JAXA. The main scientific objectives are related to the magnetosphere and exosphere of Mercury and to the interplanetary medium. The launch will be on April 2018, with the Ariane 5, and they will be inserted in orbit around Mercury at the end of 2024.
The Italian contribution is very important including four PI instruments on the MPO plus minor participation on other instruments on both modules. The accelerometer ISA, with the responsibility of INAF-IAPS, will measure with high accuracy non-gravitational accelerations. The radio science experiment MORE, with the responsibility of the University of Sapienza in Rome, will provide very accurate position of MPO with respect to the Earth and the Sun, in order to determine the parameters of the theory of General Relativity and the internal structure of Mercury.
The four sensors SERENA instrument, with the responsibility of INAF-IAPS, will monitor neutral energetic atoms and ions of the planet exosphere.
Finally the suite SIMBIO-SYS, with the responsibility of INAF-Astronomical Observatory of Padua in collaboration with INAF-IAPS and Parthenope University (Naples), composed by a stereo camera, an high resolution camera and a hyperspectral Vis-NIR imager, will provide 50% of the data volume of the entire mission through images and spectra of the entire surface of Mercury, even in 3D.

Cassini-Huygens

Cassini-Huygens conducts in-depth studies of Saturn, its moons, rings and magnetic environment and has landed on Titan, the planet's largest moon.

Cassini-Huygens is a joint NASA/ESA/ASI robotic spacecraft mission currently studying the planet Saturn and its moons. The spacecraft consists of two main elements: the NASA Cassini orbiter and the Huygens probe. It was launched on October 15, 1997 and entered into orbit around Saturn on July 1, 2004. On January 14, 2005 the Huygens probe reached Saturn's moon Titan. Italy supplied the main part of the telecom system: the high- gain antenna- HGA realized by TAS-I. Also the Italian scientific contribution to Cassini's probe is very important: Italy is contributing with the visible channel of the Visual/Infrared Mapping Spectrometer VIMS- V, contributes to the radio detection and ranging instrument RADAR, to the radio science instrument and provided the PI instrument HASI, the Atmospheric Structure Instrument on board Huygens.
When its initial four-year tour of the Saturn system was complete in 2008, the Cassini-Huygens mission had already changed our understanding of the complex and diverse Saturn system. The first two-year extension, Cassini Equinox Mission allowed the spacecraft to obtain observations of Saturn's rings as the sun lit them edge-on, revealing a host of never-before-seen insights into the rings' structure of great relevance for planetary formation and planetary science in general. Since 2010, the spacecraft has conducted a second, seven-year-long, extended mission called the Cassini Solstice Mission. This final mission will conclude in 2017 with a phase known as The Grand Finale and a final plunge into Saturn's atmosphere.
Among the remarkable discoveries obtained by Cassini are, beside the fantastic world of Saturn's rings, a first understanding of Titan's surface and atmosphere and of its Earth-like processes, and the observation on the small moon Enceladus of water ice jets produced by a hot-spot at its southern pole, which allowed to deduce the presence of liquid water beneath its surface.



DAWN

Dawn orbited and explored the giant protoplanet Vesta in 2011-2012, and now it is in orbit and exploring a second new world, dwarf planet Ceres.

Dawn orbited the protoplanet Vesta and is now in orbit around the dwarf planet Ceres as part of its mission to characterize the conditions and processes that shaped our solar system. Vesta and Ceres are the two most massive bodies in the main asteroid belt between Mars and Jupiter. By studying these two giant remnants from the epoch of planet formation, Dawn will provide scientists with new knowledge of how the solar system formed and evolved.

Dawn is a NASA Discovery mission launched on September 27, 2007. It has reached and successfully explored the asteroid Vesta in 2011. It orbited around Vesta for more than one year, giving important clues on the primordial Solar System. It reached Ceres in early 2015 and its now orbiting around it, collecting data of the innermost dwarf planet. The Dawn mission has achieved several important firsts in space exploration. It is the only spacecraft ever to orbit two destinations beyond Earth and the only to orbit an object in the main asteroid belt between Mars and Jupiter. The giant protoplanet Vesta was confirmed to be a fascinating world more closely related to the terrestrial planets (including Earth) than to typical asteroids. Like planets, it has a dense core, surrounded by a mantle and a crust. Vesta is also the source of more meteorites on Earth than Mars or the moon. Dwarf planet Ceres, larger yet less dense, is believed to have a large amount of ice and may even have subsurface liquid water. Ceres was the first dwarf planet discovered and Dawn is now studying it in detail. the first findings indicate that Ceres is more closely related to the outer Solar System bodies than to the typical asteroids. The mission represents the ideal bridge between the exploration of the inner Solar System dominated by rocky bodies and the external gaseous/icy bodies and it will allow to complete the exploration providing fundamental data on the role that the water had during the early period of the planetary evolution.

The payload is composed by 3 instruments, plus radio science. Italy provides the imaging spectrometer VIR (Visual and Infrared Spectrometer), its PI (INAF-IAPS) and several mission CO-I and team members. VIR has been built by Selex-ES.

ExoMars

Two missions: one consisting of an Orbiter plus an Entry, Descent and Landing Demonstrator Module, launched in 2016, and the other, featuring a rover, with a launch date of 2020.

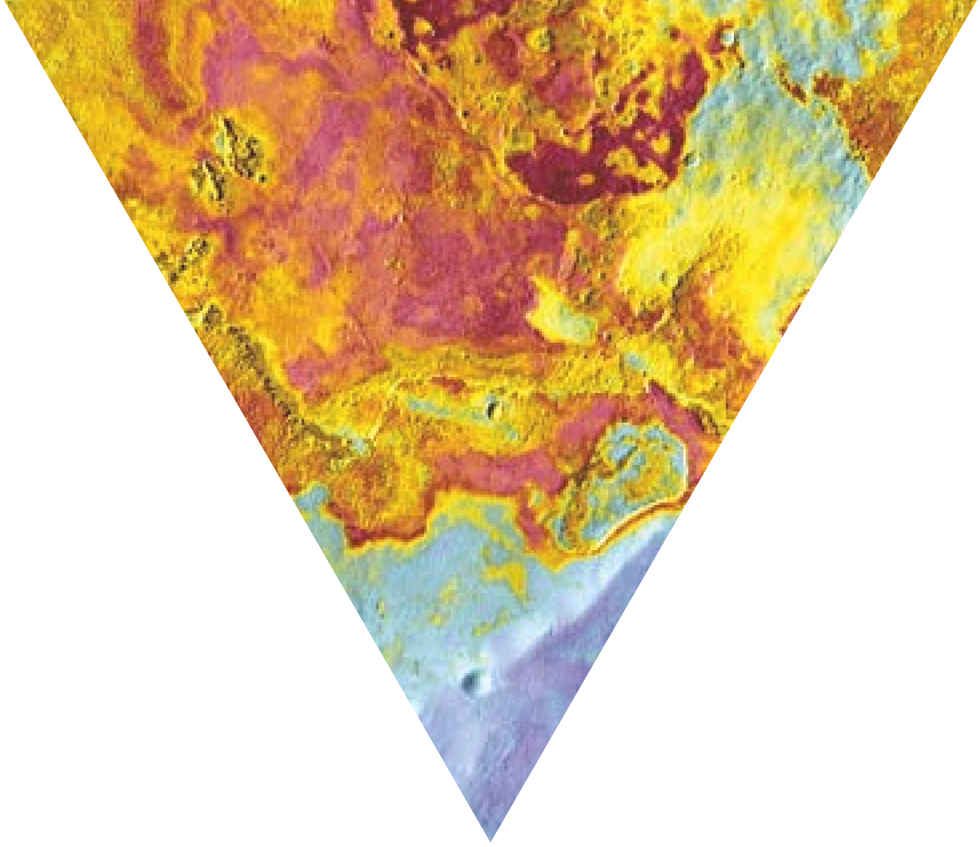
ExoMars is a scientific programme of the ESA. Divided in two distinct missions, it will investigate the Martian environment, its geochemical and geophysical characteristics, including traces of past and present life on Mars and help gather information for future manned missions to the Red Planet. The first mission in 2016 will have two main elements, the Trace Gas Orbiter (TGO) and Schiaparelli, the Entry, Descent and Landing Module (EDM). The TGO, with the Italian instrument NOMAD on board, is led by France and will study the gas composition of the atmosphere of Mars, looking for possible biological and geological activities. The EDM module Schiaparelli has an Italian leadership and will land on Mars, testing landing technologies; a key element for future missions to the planet. The second mission, expected for 2020, will have a European rover and a Russian surface platform. The rover, led by the UK, combines the capacity of movement to that of drilling the surface up to 2 meters in depth. The main objective of the rover is to find evidence of past or present life, thanks to sample analysis drilled from the ground. The Russian surface platform will transport the German landing module, and once released the rover, it will study the surrounding environment.

Italian contribution

ESA has assigned the leadership of both missions to Italy. Italy has the responsibility over all system's elements of the missions and direct responsibility over of the EDM module of ExoMars 2016, called Schiaparelli, the 2 meter long drill that will perforate Martian surface for sample retrieval and the control made by an Italian industry (Selex-ES). Italy is also responsible for the RROC in Turin, the center from which the rover will be operated.

The camera, called CaSSIS (Colour and Stereo Scientific Imaging System), is designed by the University of Bern with the help of INAF-Astronomical Observatory of Padua and ASI. CaSSIS will provide stereo colour high resolution images of Martian regions. It will also support other instruments of the TGO in the search for biologically relevant gases, like methane.

DREAMS (Dust Characterization, Risk Assessment and Environment Analyser of the Mar-



tian Surface) is a suite of sensors to measure meteorological parameters (pressure, temperature, humidity, wind velocity and direction, solar radiation) and of the electric field of Mars' atmosphere next to the Martian surface. It is a collaboration of ASI and INAF-Astronomical Observatory of Naples and University of Padua/CISAS.

AMELIA (Atmospheric Mars Entry and Landing Investigation and Analysis), will provide a model of Martian atmosphere using data collected during Schiaparelli's descent and landing on Mars' surface. It is a collaboration with University of Padua/CISAS.

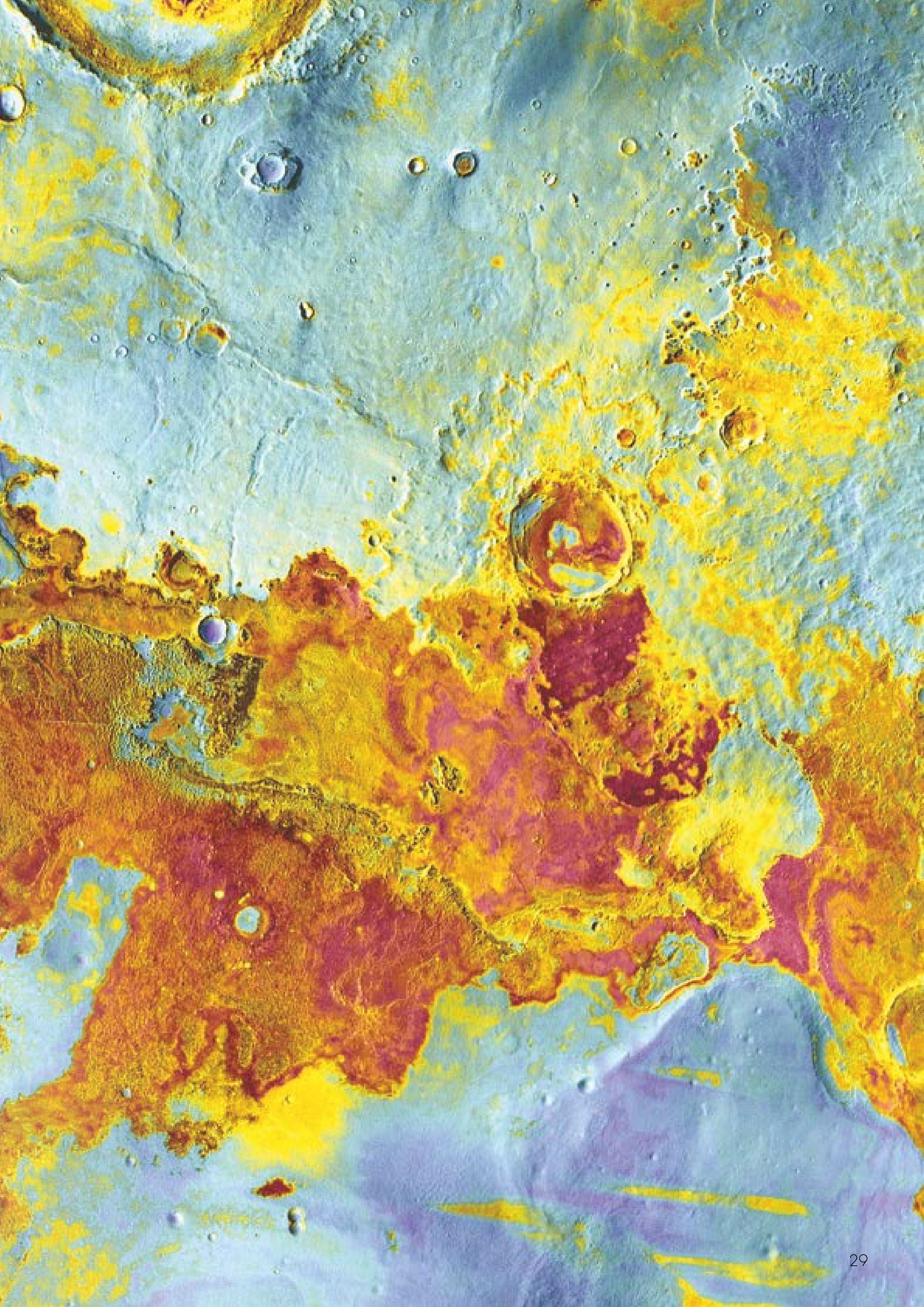
MA_MISS (Mars Multispectral Imager for Subsurface Studies) is a spectrometer inside the rover's drill, that will analyze the geological and biological evolution of the subsurface of Mars, providing the necassary context for the sample analysis. It is provided by ASI under the scientic leadership of INAF-IAPS.

INRRI (Instrument for landing-Roving laser Retroreflector Investigations) is a Cube Corner laser Retroreflector produced by ASI and the Italian National Institute for Nuclear Physics (INFN).

Schiaparelli

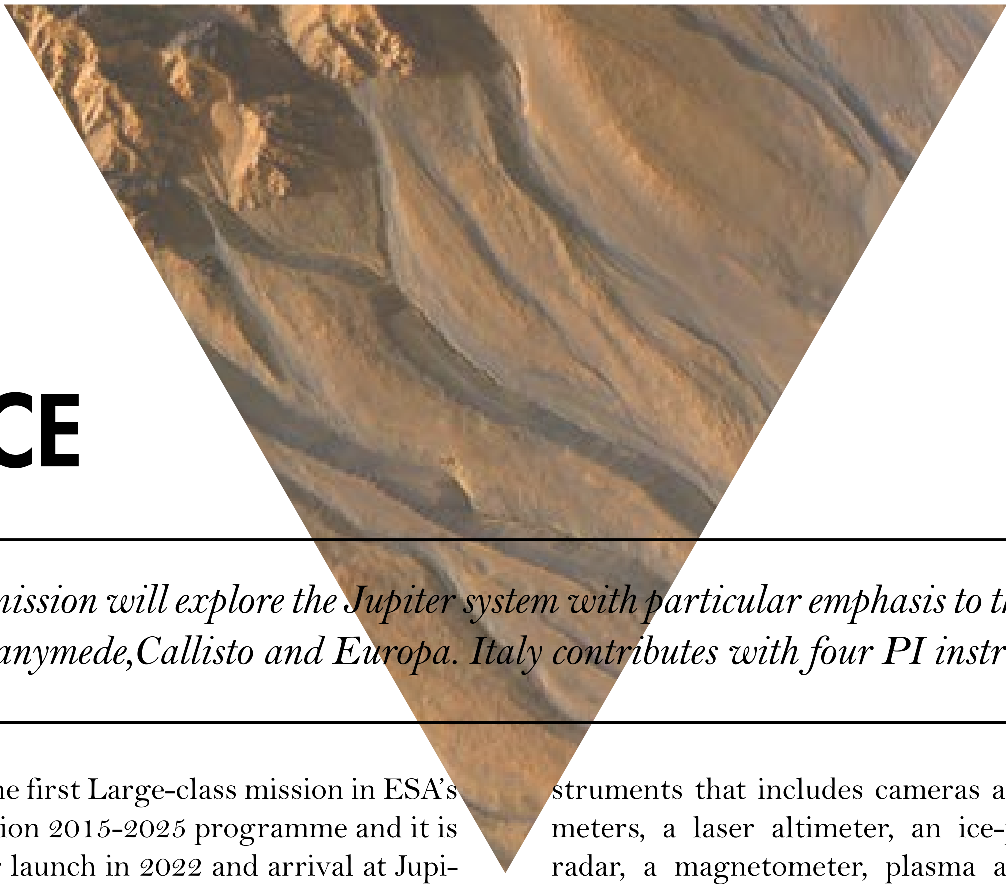
The ExoMars landing site.

The ExoMars 2016 entry, descent, and landing demonstrator module, also known as Schiaparelli, will touch down on Meridiani Planum, a relatively smooth, flat region on Mars, on 19 October 2016. One of the reasons for choosing this landing site was because of its relatively low elevation, which means that there is a sufficient thickness of atmosphere to allow Schiaparelli's heat shield to reduce the module's velocity and get ready to deploy its parachute. The final firing of its thrusters will ensure a soft and controlled landing.



Gaia

A general description is given in Commission E.



JUICE

JUICE mission will explore the Jupiter system with particular emphasis to the planet's moons Ganymede,Callisto and Europa. Italy contributes with four PI instruments.

JUICE is the first Large-class mission in ESA's Cosmic Vision 2015-2025 programme and it is planned for launch in 2022 and arrival at Jupiter in 2030. It will spend at least three years making detailed observations of the biggest planet in the Solar System and three of its largest moons, Ganymede, Callisto and Europa. These moons are thought to harbour vast water oceans beneath their icy surfaces and JUICE will map their surfaces, sound their interiors and assess their potential for hosting life in their oceans.

JUICE will have on board a complement of instruments that includes cameras and spectrometers, a laser altimeter, an ice-penetrating radar, a magnetometer, plasma and particle monitors, radio science hardware.

The Italian contribution to JUICE is relevant for the payload, in particular for the camera (JANUS), the spectrometer (MAJIS), the ice-penetrating radar (RIME) and the radio science experiments (3GM). The mission has been adopted by ESA at the end of 2014 and the program is currently in phase B2, toward the preliminary design review attended in the next months.

Mars Express

Mars Express is a space exploration mission being conducted by the European Space Agency (ESA) at Mars. Italy participates in five of the seven scientific experiments: the PFS spectrometer, the MARSIS radar, the OMEGA imaging spectrometer, the ASPERA plasma instrument and the HRSC camera.

Mars Express is a space exploration mission being conducted by ESA. Launched in 2003, Mars Express is still exploring the planet Mars, and was the first planetary mission attempted by the agency. In addition to global studies of the surface, subsurface and atmosphere of Mars with unprecedented spatial and spectral resolution, the unifying theme of the Mars Express mission is the search for water in its various states, everywhere on the planet, using different remote sensing techniques with each of its seven instruments. The exploration of the martian moons, Phobos and Deimos, is a secondary objective of the mission, achieved via multiple flybys of Phobos about every five months.

Italy provided or participates in five of the seven scientific experiments: the PFS spectrometer, the MARSIS radar, the OMEGA imaging spectrometer, the ASPERA plasma instrument and the HRSC camera. The first two experiments have been developed under Italian leadership, OMEGA and ASPERA see a significant Italian contribution both in hardware and science, while participation in HRSC is solely scientific.

The Planetary Fourier Spectrometer (PFS) has made the most complete map to date of the chemical composition of the atmosphere, indicating the possible presence of methane. If confirmed by the Exomars Trace Gas Orbiter mission, this could indicate geological processes that are still active today, or even active biochemical processes. PFS also produced temperature maps from the surface up to an altitude of about 50 km.

The subsurface sounding radar (MARSIS) identified the presence of water-ice deposits underground and revealed the fine layering of polar deposits. The radar has also been probing the upper atmospheric layer (the ionosphere) and shown interesting structures associated with localised magnetic fields in the Martian crust, which originate near the surface of Mars.

The Infrared Mineralogical Mapping Spectrometer (OMEGA) has provided unprecedented maps of water-ice and carbon dioxide-ice in the polar regions. It also determined that the presence of phyllosilicates in some areas of the surface is a sign that abundant liquid water existed in the early history of Mars.

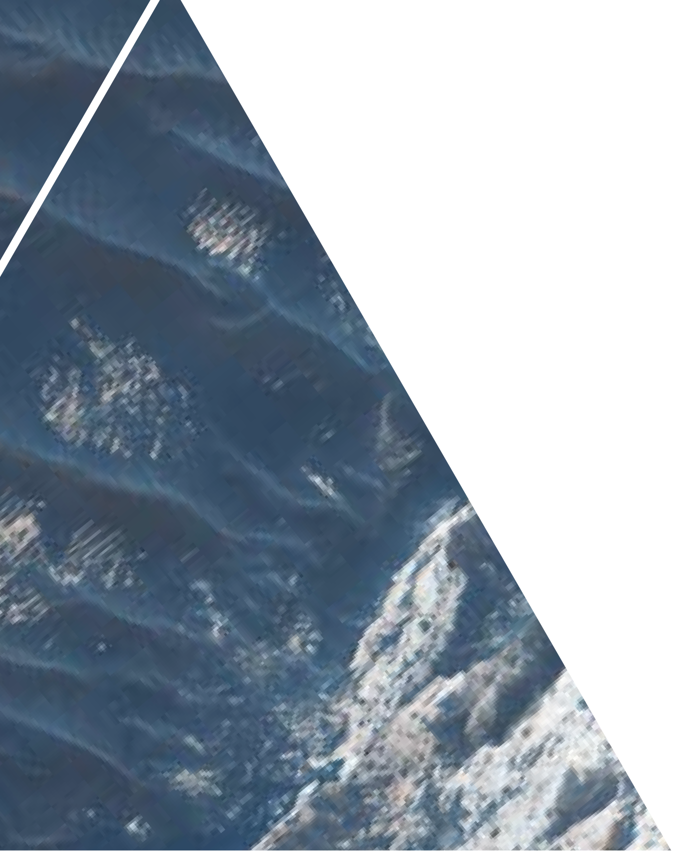
The Energetic Atoms Analyser (ASPERA) has identified solar wind scavenging of the upper atmospheric layers as one of the main culprits of atmospheric degassing and escape.

The High-Resolution Stereo Camera (HRSC) has shown very young ages for both glacial and volcanic processes, from hundreds of thousands to a few million years old, respectively.

MRO

Mars Reconnaissance Orbiter is a NASA planetary mission carrying SHARAD, an Italian low-frequency radar that can probe the Martian subsurface to depths of up to 1 km to detect ice or water.

Mars Reconnaissance Orbiter (MRO) is a NASA planetary mission that aims to determine whether life ever arose on Mars, to characterize the climate and geology of the planet, and to prepare for human exploration. The payload consists of six scientific instruments to study the atmosphere, surface and subsurface from orbit. The probe was launched in August 2005 and commenced operations at Mars in early 2006. The mission has been extended well past its original intended lifetime, and is expected to continue at least until 2017. ASI provided the SHARAD facility instrument, a low-frequency radar that can probe the Martian subsurface to depths of up to 1 km to detect the presence of ice or water.



Rosetta

Rosetta is the ESA cornerstone mission devoted to study the origin of our Solar System closely following the comet 67P/ Churyumov-Gerasimenko. Launched in 2004 the mission will end on September 2016. Italy is participating to several instruments: the imaging spectrometer VIRTIS, the camera OSIRIS, the dust analyzer GIADA and SD2, the driller on-board the lander.

Rosetta, a cornerstone ESA mission, has been launched on March 2, 2004 and is now orbiting the comet 67P/ Churyumov-Gerasimenko. The comet has been reached on 6 August 2014, after two successful fly-bys with the asteroids Steins (2008) and Lutetia (2010). On 12 November 2014, Rosetta's lander Philae, a joint realization by DLR-CNES-ASI aimed at the detailed in-situ analysis, was deployed to the surface. Rosetta has been following and studying the comet through perihelion (August 2015) with its remote sensing and in-situ instruments and will continue until the end of the extended mission, the 30th September 2016. Italy is contributing or participating to various instruments. The visible and infrared thermal imaging spectrometer VIRTIS, under the responsibility of INAF-IAPS, is devoted to the study of the composition of the surface and the coma of the comet, and the derivation of surface temperature. OSIRIS is a camera system operating in the near ultraviolet, visible and near infrared range. It is composed by two independent cameras, wide angle and narrow angle, and the wide angle camera has been built under the responsibility of the University of Padua/CISAS. The dust analyzer GIADA, devoted to the study of the dust in the coma, has been built by the Parthenope University (Naples) and INAF-Astronomical Observatory of Naples and is managed by INAF-IAPS. SD2, the driller and sample retriever on-board the lander Philae, has been built by the Politecnico di Milano. The italian instruments are providing important results on the composition of the surface and of the gas and dust in the coma and on the physical processes acting on the nucleus.

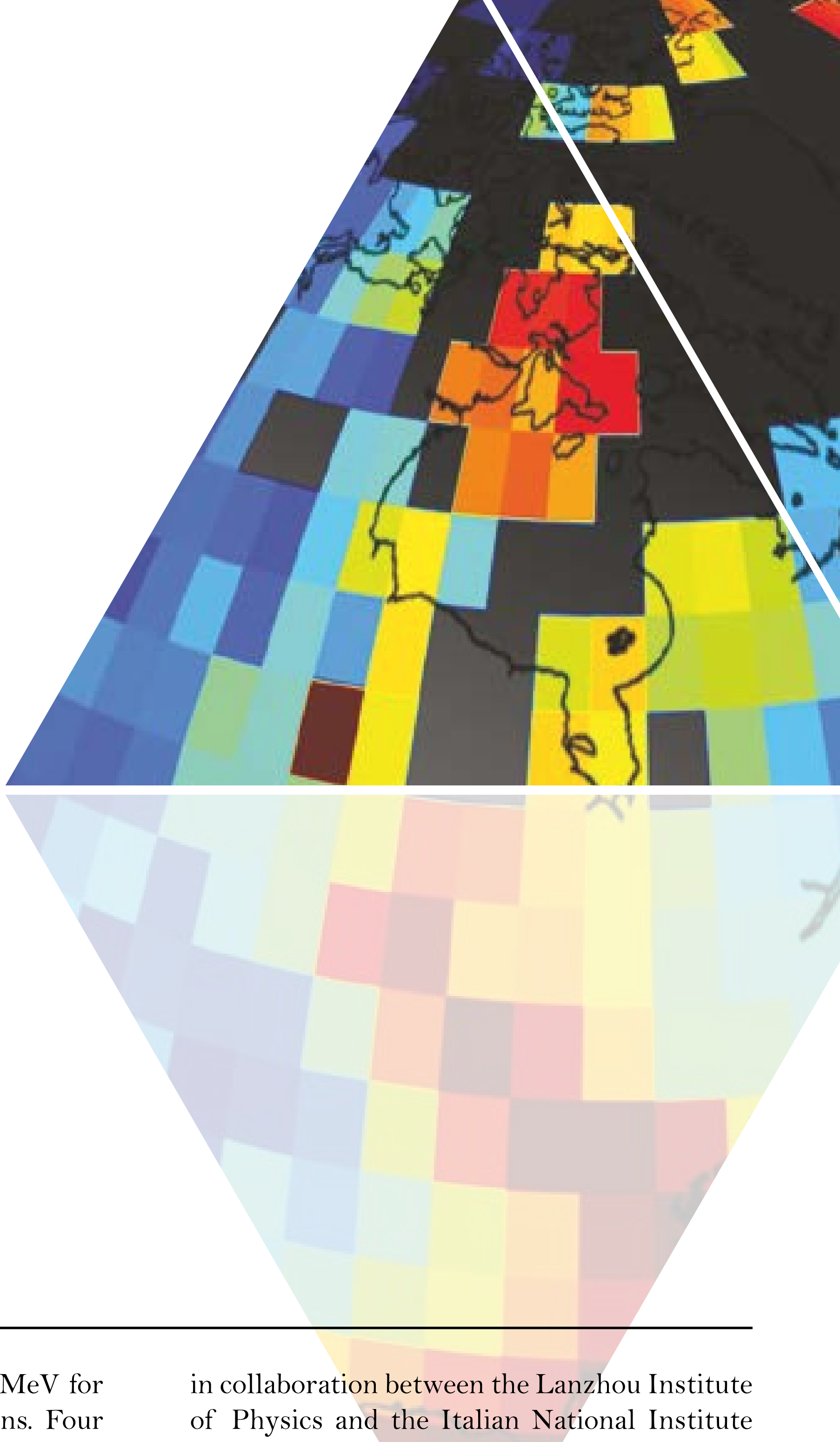
ABCDEFGHIJKL

Scientific Commission

CSES-Limadou

CSES (China Seismo-Electromagnetic Satellite) is a scientific mission mainly dedicated to the monitoring of perturbations in the ionosphere, and magnetosphere and the Van Allen belts due to electromagnetic phenomena and to study their correlations with seismic events. CSES will be placed at Sun-syncronous circular orbit at an altitude of 500 km.

CSES is a mission of China National Space Administration and ASI. The satellite, 3-axis attitude stabilized, is based on the Chinese CAST2000 platform. It will be placed at a 98° Sun-syncronous circular orbit at an altitude of 500 km, with the launch scheduled in the first half of 2017 and an expected lifetime of 5 years. The main objective of the mission is the monitoring of perturbations in the ionosphere, and magnetosphere and the Van Allen belts due to electromagnetic phenomena of natural and anthropogenic origin, and to study their correlations with seismic events. Furthermore, CSES mission will allow to study the physical properties of the ionospheric plasma at the satellite altitude, to characterize the ionosphere in quiet and disturbed conditions. Cosmic and solar physics studies, namely Coronal Mass Ejections (CMEs), solar flares, solar energetic particles (SEPs), cosmic ray modulation, X-rays variation are other relevant topics that can be covered by the mission as well. Italy participates with several universities and research institutes. INAF and Italian National Institute for Nuclear Physics (INFN) are directly involved in instrumental development and test respectively. The High-Energy Particle Detector (HEPD), developed by the INFN and several Italian universities, will detect high energy electrons, protons and light nuclei. Its main objective is to measure the increase of the electron and proton flux due to short-time perturbations of Earth's environment caused by cosmic, solar, and terrestrial phenomena.



The energy range explored is 5-100 MeV for electrons and 15-300 MeV for protons. Four Electric Field Detectors (EFD) have been specifically designed to allow the monitoring of electromagnetic fields (from DC to 3.5 MHz) for the study of ionospheric disturbances possibly related to seismic activity and earthquake preparation mechanisms. In particular, the mission aims at analyzing the temporal correlation between seismic events and the occurence of electromagnetic perturbations. The environmental plasma parameters, including ion density, ion temperature, ion drift velocity, ion composition and ion density fluctuation, will be monitored by the CSES Plasma Analyser (PA) and by two Langmuir probes (Lp) developed by CSSAR-CAS. The EFDs have been designed in collaboration between the Lanzhou Institute of Physics and the Italian National Institute for Nuclear Physics (INFN-Rome Tor Vergata) and INAF-IAPS. Two versions of EFD with different electronics have been developed by Chinese and Italian teams and their functionalities compared one each other and tested at the Plasma Chamber at INAF-IAPS as well as the Plasma Analyzer and Langmuir probes, in order to check their sensitivity in detecting the ionospheric plasma parameters.

DUSTER

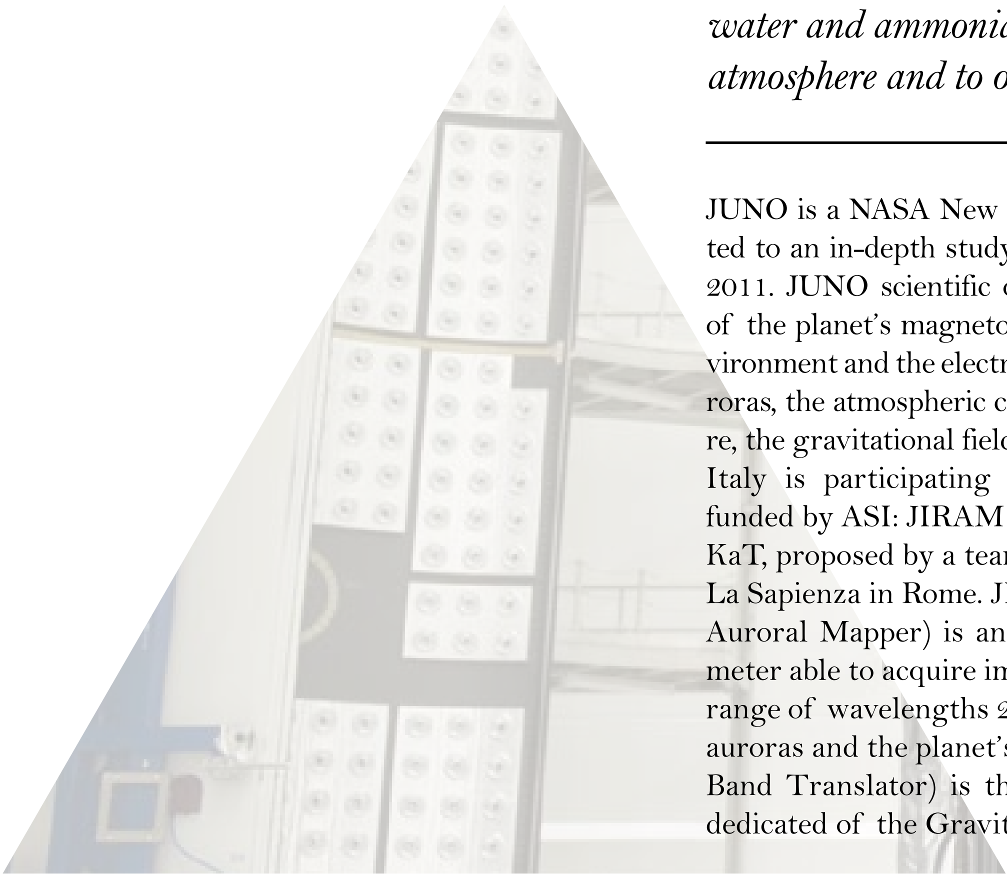
DUSTER (Dust in the Upper Stratosphere Tracking Experiment and Retrieval) is aimed at uncontaminated collection, retrieval and laboratory analysis of stratospheric solid aerosol particles from the upper stratosphere. The approach implies: in-situ particles collection and store in controlled conditions; sample recovering; and laboratory analyses.

DUSTER is a multinational project aimed at collection and retrieval of solid micron-submicron dust from upper stratosphere (altitude >30km). Dust particles are collected and analysed in laboratory by state of the art analytical techniques for a physico-chemical characterization and disentanglement of the terrestrial and extra-terrestrial component. DUSTER results are related with planetology, astrophysics and atmospheric physics. Solid and condensed sub-micrometre particles present in the Stratosphere are a mix of terrestrial and extra-terrestrial dust. The extra-terrestrial component is highly represented in the upper Stratosphere while volcanic eject residues are more prevalent than in lower Stratosphere. The main and most ambitious goal is the collection and characterization of Solar System debris particles <3 microns not sampled by the stratospheric aircraft/NASA collection facility. In addition, no other instrument/facility does currently sample the upper stratosphere. DUSTER provides a record of the amount of solid aerosols, their size distribution, shapes and chemical properties in the upper stratosphere, for particles down to about 0.5 micron in size. Two fully successful DUSTER flights were performed from the Stratospheric Base in Svalbard Islands, Norway in June 2008 and July 2009, supported by ASI and a third flight was performed in 2011 from Kiruna, Sweden, thanks to CNES. The National Antarctic Research Project (PNRA) funded a DUSTER launch campaign from Antarctica, which will take place at the end of 2016. Compositions, morphologies and structure of the analysed particles, which were randomly collected in the upper Stratosphere during the 2008 and 2011 flights, are consistent with ultra-rapid, non-equilibrium processes and fragmentation of extra-terrestrial bolides entering the Earth atmosphere. Thanks to DUSTER for the first time extra-terrestrial dust from these sources has been intercepted while settling in the Earth's Stratosphere. The project has been supported by ASI, PNRA, CNES, the Italian Ministry of the Environment, the Italian Ministry of Instruction, Research and University, the Foreign Ministry and Regione Campania. DUSTER could become a permanent facility for extra-terrestrial dust collection in the upper Stratosphere. The Italian man power contribution is assured by INAF-IAPS and Dipartimento di Scienze e Tecnologie, Parthenope University (Napoli).

JUNO

Juno's goals are to understand the evolution of Jupiter, to look for a solid core, to map its magnetic field, to measure water and ammonia in the planet's deep atmosphere and to observe its auroras.

JUNO is a NASA New Frontiers mission devoted to an in-depth study of Jupiter, launched in 2011. JUNO scientific objectives are the study of the planet's magnetosphere, its radiation environment and the electromagnetic fields, the auroras, the atmospheric composition and structure, the gravitational field and the planet interior. Italy is participating with two instruments funded by ASI: JIRAM led by INAF-IAPS and KaT, proposed by a team led by the University La Sapienza in Rome. JIRAM (Jovian InfraRed Auroral Mapper) is an imager and a spectrometer able to acquire images and spectra in the range of wavelengths 2-5 µm to study infrared auroras and the planet's atmosphere. KaT (Ka-Band Translator) is the K-Band transponder dedicated of the Gravity Science experiment.



Jupiter

Packing up JUNO mission.

Juno will let us take a giant step forward in our understanding of how giant planets form and the role these titans played in putting together the rest of the solar system.

ABCDEFGHIJKL

Scientific Commission

ASPIICS

The ASPIICS coronagraph is the guest payload of the ESA Proba-3 technological mission. ASPIICS is formed by two spacecraft in flight formation and is developed by a European consortium including ASI.

ASPIICS is a coronagraph imaging the solar corona out to 3 solar radii, under development for ESA Proba-3 technological mission, which is devoted to prove high-precision formation-flight technologies. A pair of satellites will fly together maintaining a fixed configuration as a large rigid structure in space. The two satellites will form a 150-m long solar coronagraph to study the Sun's faint corona closer to the solar limb than has ever before been achieved from space in visible light. ASI and INAF, part of a large European consortium, are responsible for coronagraphic calibrations, optimization of the occulter and for contributing the spectral filters. The launch is foreseen in 2019.

CLUSTER

The first space mission composed by a fleet of four S/C which provided in situ tridimensional measurements permitting significant advance in the knowledge of fundamental space plasma processes.

CLUSTER is an ESA Horizon 2000 cornerstone mission launched in 2000 and extended until 31 December 2018 (subject to a midterm review in 2016). CLUSTER comprises four spacecraft, flying in a tetrahedral formation, which carry an identical set of instruments for the in situ measurements of charged particle and fields. Italy, in the framework of an international collaboration, contributed to the development of the mechanics and the onboard SW of the Cluster Ion Spectrometry (CIS) experiment. CLUSTER scientific data analysis in Italy pertains to the study of fundamental plasma processes as magnetic reconnection and turbulence occurring in the key regions of the magnetosphere.

BepiColombo

A general description is given in Commission B.

Hinode

Hinode is a Japanese mission observing the Sun in the optical, EUV and X-ray band. Italy has worked on the instrument calibration and studied the magnetic photosphere and the hot and dynamic corona.

Hinode is a JAXA solar mission (Japan), with USA and UK contributions, devoted to study solar activity, since 2006. A set of instruments in the optical (SOT), EUV (EIS) and X-ray band (XRT) are on-board Hinode. INAF has been directly involved in the calibration of the XRT telescope, with its XACT/OAPA laboratories. Hinode scientific data analysis in Italy pertains to the study of the fine magnetic dynamics and structure of the active photosphere (SOT), of the eruptions and holes, the hot intermittent components and the fine thermal structure of the corona (EIS, XRT). The transit of Venus observed also with the XRT has been used to probe the upper planetary atmosphere.

SCORE

Prototype of the Solar Orbiter coronagraph Metis, was successfully launched in 2009 as part of the NASA suborbital flight program HERSCHEL. Second flight foreseen in 2017.

SCORE, prototype of the Solar Orbiter coronagraph Metis, was successfully launched in a suborbital flight in 2009 from the White Sands Missile Range, US. SCORE is part of the HERSCHEL program approved by NASA and led by the Naval Research Laboratory, US. Its second flight, in 2017, is in preparation. SCORE is the first multi-band coronagraph obtaining simultaneous images of the solar corona in polarized visible light and in the UV and EUV Ly alpha lines of H and He, respectively. In the 2009 flight, the first maps in Helium emission and abundance of the solar corona have been obtained. SCORE, an INAF-ASI instrument, has been developed by INAF-Astronomical Observatory of Turin and by the University of Firenze.

SOHO

SOHO is an ESA-NASA solar mission studying the Sun, from its interior to the solar wind. Italy contributed with the spectrometer of the UVCS coronagraph and hosts SOLAR, one of SOHO data archives.

The solar observatory SOHO, an ESA-NASA mission launched in 1995, monitors the Sun from L1 since 1996 with twelve instruments, in part still operative. The SOHO UltraViolet Coronagraph Spectrometer, UVCS, a NASA-ASI collaboration, flawlessly operated until 2012. The Italian solar physics community was responsible for the development of the UVCS spectrometer and hosts the SOHO data archive, SOLAR. UV spectroscopy of the outer corona was first introduced with UVCS, leading to fundamental discoveries on energy deposition in the coronal wind and on solar eruptions. Data are at present actively studied also in view of developing planning tools for Solar Orbiter and for space weather forecast.

Solar Orbiter

Selected as the Cosmic Vision M1 mission, Solar Orbiter is ESA's primary contribution to ILWS. It will contribute to reveal how the Sun creates and drives the heliosphere.

Solar Orbiter (European Space Agency) provides the unique opportunity to discover the fundamental links between the magnetized solar atmosphere and the dynamics of the solar wind that, ultimately, is the source of space weather. In October 2011, Solar Orbiter was selected as the Cosmic Vision M1 mission and entered the implementation phase in 2012 to be launched in October 2018. The Solar Orbiter unique mission profile allows the investigation of the Sun at very high spatial resolution by taking advantage of a close-by vantage point at a perihelion of 0.28 AU and of an orbital inclination exceeding 30°, towards the end of the mission, which will allow to observe the polar regions from above. These observations from remote, together with the measurements provided by the in-situ instruments will represent the necessary ingredients to unravel the mechanisms at the basis of generation and heating of the solar corona.
The scientific payload includes the Metis coronagraph, consisting in a coronal imager working in both polarized VL and UV light. This coronagraph has an Italian PIship (INAF-Astronomical Observatory of Turin) and is realized in Italy under ASI contract. Germany (MPS) and Czech Republic (Academy of Sciences) provide a HW contribution. Metis can simultaneously image the visible and ultraviolet emission of the solar corona and diagnose, with unprecedented temporal coverage and spatial sampling element (down to about 4000 km), the structure and dynamics of the full corona in the range from 1.6 to 3.0 solar radii at minimum perihelion (0.28 AU), and from 2.8 to 5.5 solar radii at 0.5 AU. This region is crucial in linking the solar atmosphere phenomena to their evolution in the inner heliosphere, and the study of its properties is very important in meeting the Solar Orbiter fundamental science goals.
The scientific payload of Solar Orbiter also includes Solar Wind Analyser (SWA), a plasma analyser suite with 4 sensors and a single, common Detector Processing Unit (DPU). SWA will measure particle velocity distribution functions of protons, helium, minor ions and electrons of the solar wind with unprecedented sampling time resolution, of the order of the proton scales.. SWA has an Italian Co-PIship (INAF-IAPS), responsible for realizing the common DPU under ASI contract.
There is also a participation of the group of Genoa (University, CNR/SPIN) to the Spectrometer Telescope for Imaging X-rays (also supported by ASI). The italian contribution (CoIship) consists in the flight software for flare detection and real-time science data analysis.

STEREO

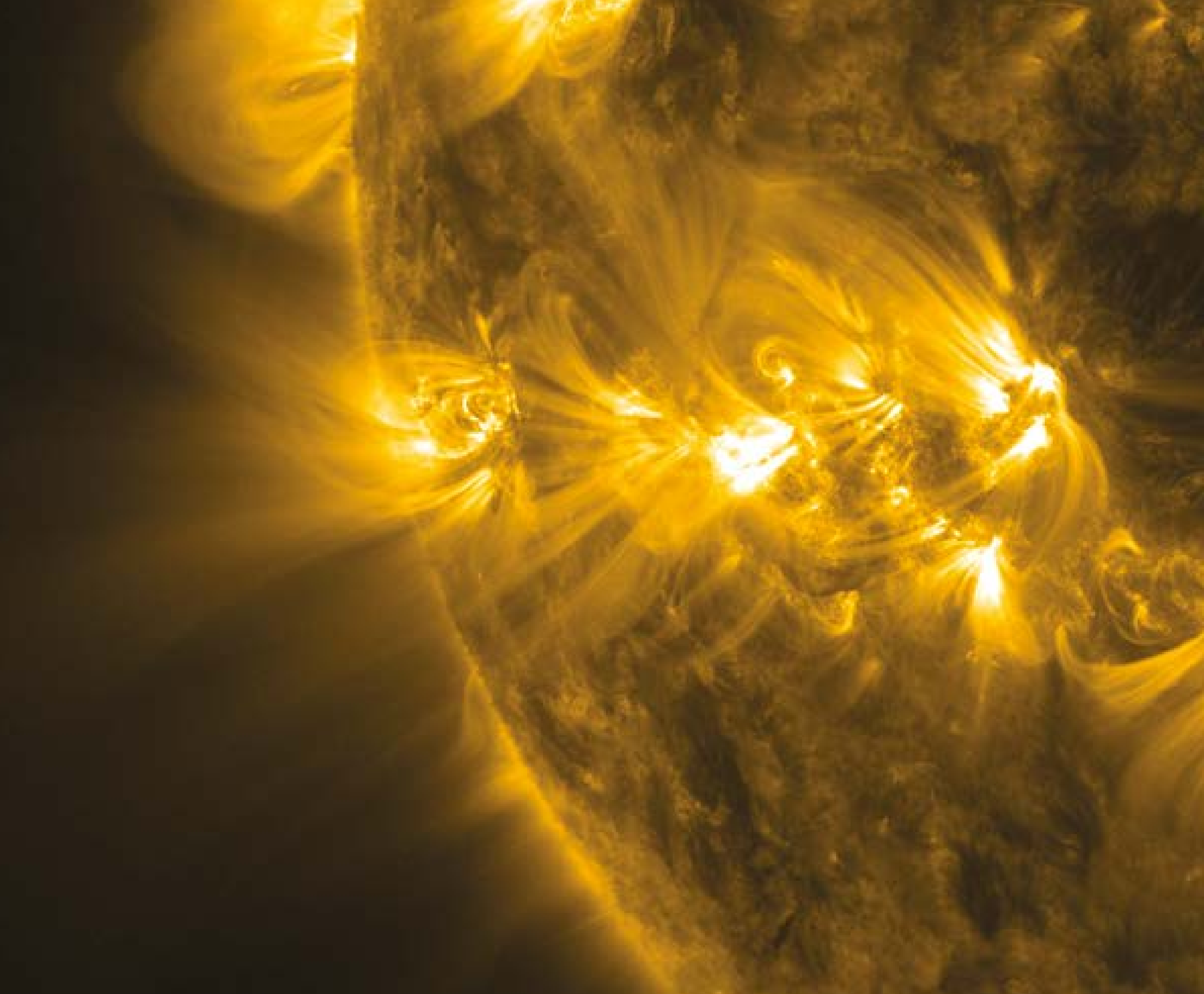
Two space-based observatories, one ahead of Earth in its orbit, the other trailing behind. Their goal is to study the structure and evolution of solar storms.

STEREO has been launched in 2006. STEREO consists of two spacecraft. They separate from earth in opposite directions at a rate of 22° per year, in order to obtain a stereoscopic view of the solar atmosphere. The two spacecraft are equipped with the same set of instruments for remote sensing and in situ observations of the Sun and of the heliosphere. The Italian solar physics community is involved in the analysis of data from the instruments SWAVES and IMPACT, finalized to the investigation of turbulence in the solar wind and particle acceleration, and from the instruments COR2 and HI, designed to study the solar wind acceleration with correlation tracking techniques and the physics of coronal mass ejections.

THOR

Turbulence Heating ObserveR is a candidate for the ESA's next M4 mission. It is the first dedicated mission to solve the fundamental question of turbulent energy dissipation and particle energization in space plasmas, scientific subjects of great relevance for astrophysical and laboratory plasmas as well.

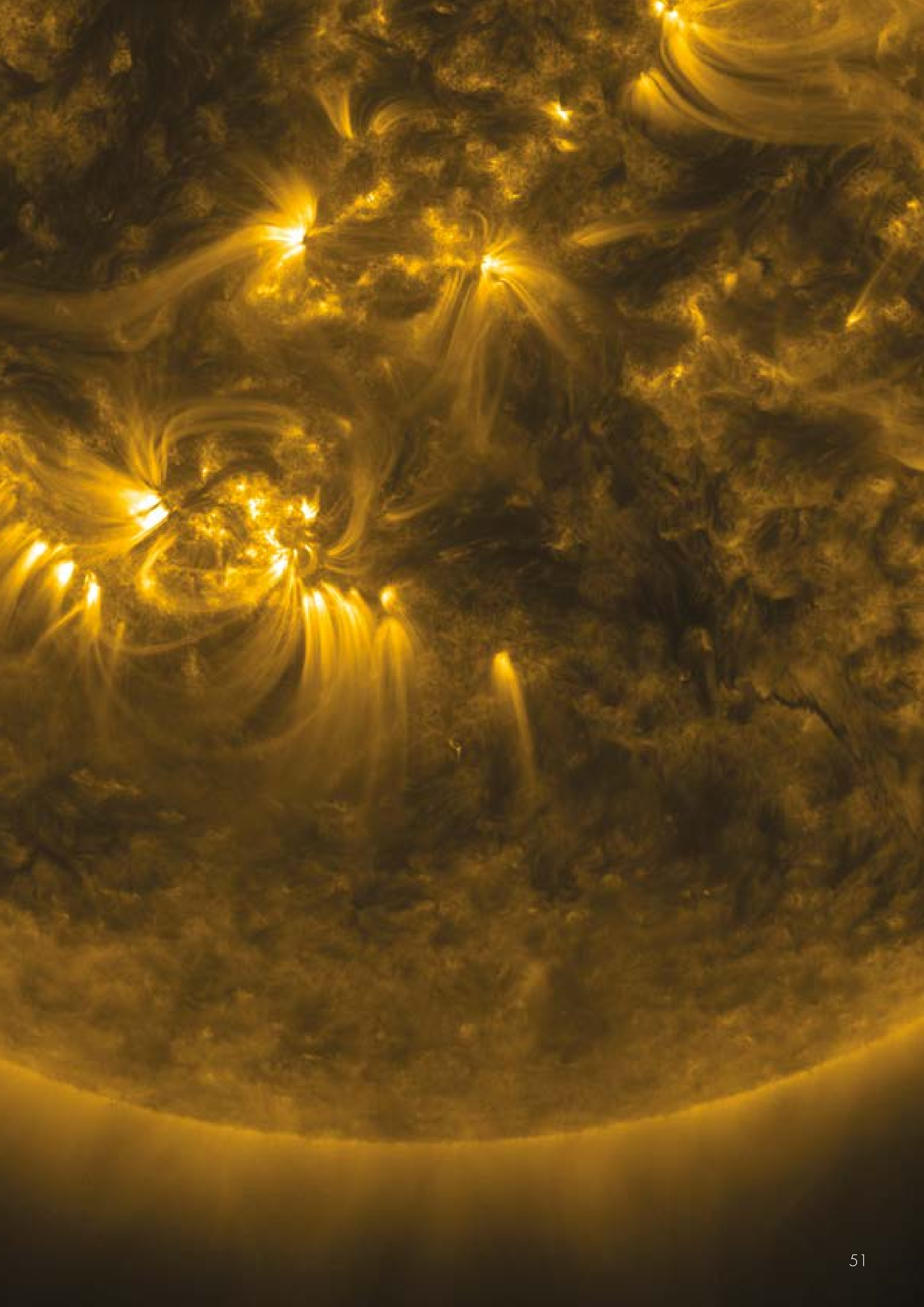
The Universe is permeated by hot, turbulent magnetized plasmas where particles are heated and accelerated as a result of energy dissipation in turbulent environments. THOR aims to unveil plasma physics at kinetic scales, where most of the irreversible dissipation of energy within turbulent fluctuations occurs. This would be a leap forward in the comprehension of fundamental plasma processes with applications to very different astrophysical, solar system and laboratory plasma environments. This objective can be reached thanks to unprecedented high time resolution and high accuracy particle and fields in situ measurements provided by the THOR payload in the closest available dilute and turbulent magnetized plasmas: solar wind, Earth's bow shock and interplanetary shocks, and compressed solar wind regions downstream of shocks. Moreover, such measurements will be complemented with increasingly extreme sophisticated numerical simulations. The Italian contribution to THOR is important, with the PI ship of the central processing unit, which will provide a single interface to the spacecraft as well as commanding and data handling for all the four particle instruments on board THOR, with the guidance of the team for the crucial numerical support and with valuable contribution to the THOR science. The mission is scheduled for launch in 2026.



Sun

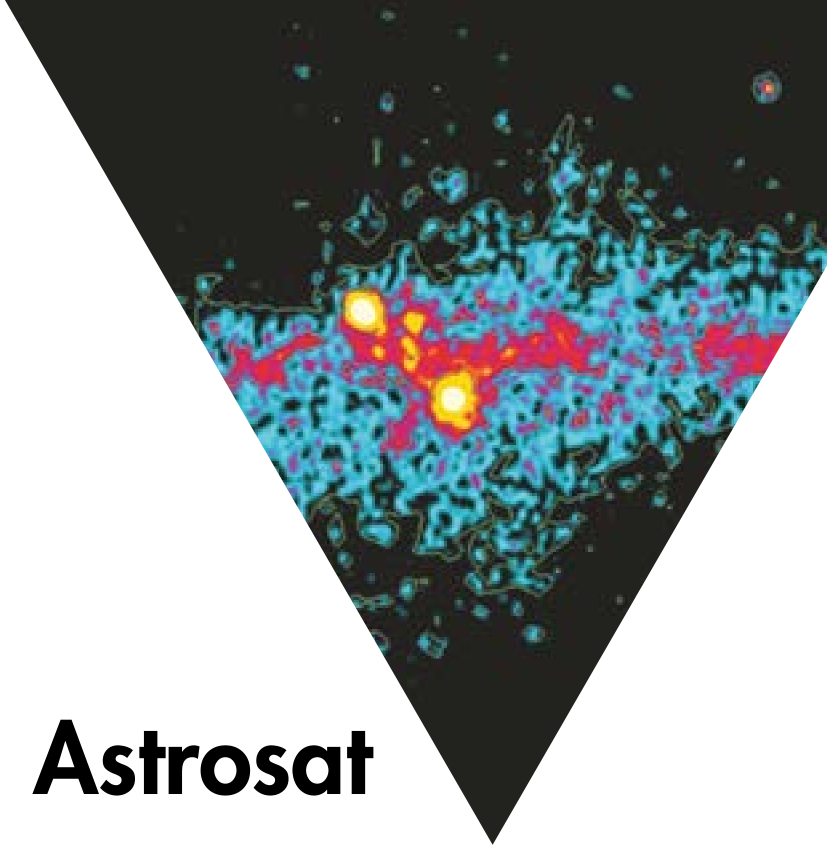
Exploring Sun-Heliosphere Connection.

The heliosphere represents a uniquely accessible domain of space, where fundamental physical processes common to solar, astrophysical and laboratory plasmas can be studied under conditions impossible to reproduce on Earth and unfeasible to observe from astronomical distances.



ABCDEFGHIJKL

Scientific Commission



AGILE

An X-ray and Gamma ray astronomical satellite of the Italian Space Agency.

AGILE is an ASI space mission dedicated to high-energy astrophysics. The main goal is the simultaneous detection of hard X-ray and gamma-ray cosmic radiation in the energy bands 18-60 keV and 30 MeV - 30 GeV with optimal imaging and timing capability. The AGILE satellite was launched on April 23, 2007 from Sriharikota (India). It has been collecting crucial astrophysical data since then, and it contributed to the study of Galactic and extragalactic cosmic sources. We mention here the discovery of very intense gamma-ray emission from a class of active blazars (e.g., 3C 454.3), the detection of pulsars and pulsar wind nebulae, the discovery of extreme acceleration in the microquasars Cygnus X-3 and Cygnus X-1, the direct evidence for hadronic cosmic-ray acceleration in several Supernova Remnants, the detection of several GRBs as well as the detection at the highest energies of Terrestrial Gamma-Ray Flashes (TGFs). Particular care is devoted to multifrequency programs, and the AGILE gamma- ray observations have been systematically linked and interpreted in synergy with radio, optical, X-ray and TeV results.

Astrosat

Reopen a window onto X-ray fast timing, with an interactive software developed by INAF.

Astrosat was launched on 2015 September 28 into a LEO. It carries on board two 38-cm optical/UV telescopes, an array of 3 proportional counters (3-80 keV, 8000 cm2 @ 10 keV), a soft X-ray telescope (0.3-8 keV, 120 cm2 @ 1 keV), a CZTI coded-mask imager (10-150 keV, 480 cm2) and an All-Sky monitor. It is operated as an observatory. An open AO for 10% of observing time will be released in 2019, increased to 20% the next year. The Italian participation is through the software for timing analysis GHATS, developed at INAF-Astronomical Observatory of Bologna, for the analysis of bright X-ray sources. One Italian scientist is part of an instrument team and currently collaboration projects with INAF-Astronomical Observatory of Bologna scientists are under way.

Athena

Most pressing questions in Astrophysics for the late 2020s can uniquely be addressed with X-ray observations.

Athena is an X-ray observatory to be proposed as a large mission for ESA science program. It is conceived to answer some of the most pressing questions in Astrophysics for the late 2020s that can uniquely be addressed with X-ray observations. Athena will transform our understanding of two major components of the Cosmos. The Hot Universe: the bulk of visible matter in the Universe comprises hot gas which can only be accessed via space-based facilities operating in the X-ray band. Revealing this gas and relating its physical properties and evolution to the cosmological large-scale structure and to the cool components in galaxies and stars, is essential if we want to have a complete picture of our Universe. The Energetic Universe: accretion onto black holes is one of the major astrophysical energy generation processes, and its influence via cosmic feedback is profound and widespread. X-ray observations provide unique information about the physics of black hole growth and the causes and effects of the subsequent energy output, as well as revealing where in the Universe black hole accretion is occurring and how it evolves to the highest redshifts.

CALET

In search for possible signatures of dark matter in the spectra of electrons and gamma rays.

The CALorimetric Electron Telescope reached the ISS in August 2015 starting an initial 5 year period of data taking on the JEM-EF exposure facility. CALET is a mission of the Japanese Aerospace Agency (JAXA) in collaboration with ASI and NASA. CALET main science objective is the exploration of the electron spectrum above 1 TeV whose shape might reveal the presence of nearby acceleration sources at kpc distance from Earth. With excellent energy resolution, proton rejection capability and low background contamination, CALET will search for possible signatures of dark matter in the spectra of electrons and gamma rays. Deviation from a simple power-law in proton and He spectra will be studied with high precision in the region of a few hundred GeV and extended to the multi-TeV region and to heavier nuclei. Energy spectra, relative abundances and secondary-to-primary ratios of cosmic nuclei from proton to iron will be measured. Heavier elements up to Z=40 will be studied. To date, several gamma-ray transients have been detected by a dedicated Gamma-ray Burst Monitor (GBM).

Chandra

Sophisticated telescope specially designed to detect X-ray emission from very hot regions of the Universe such as exploded stars, clusters of galaxies, and matter around black holes.

The Chandra X-ray observatory has been launched July 23, 1999. Since the launch, scientists all over the world took advantage of the excellent imaging capabilities of the observatory. These were used perform deep pencil beam surveys in order to disentangle the origin of the X-ray background. Moreover, Chandra allowed to separate close-by double AGN in merging galaxies and to detail AGN eclipses due to gas and dust clouds in close AGN. Chandra was also used to study galaxy clusters and, in particular, the interactions between the central giant galaxy and the intra-cluster medium. The excellent capabilities of Chandra were fundamental to study celestial objects in the crowded fields of the Milky Way. In particular, Chandra gave a fundamental contribution in the study of the present and past activity of the nucleus of our own Galaxy. The INAF-Astronomical Observatory of Palermo has been involved in the instrumental development and calibration of the filters of the High Resolution Camera on board Chandra.

CHEOPS

The first Small mission in ESA Cosmic Vision 2015-25 program, selected for a launch in 2018. Primary goal: characterizing transiting exoplanets on known bright and nearby host stars.

CHEOPS is dedicated to the determination of the internal structure of small-size transiting planets by means of ultrahigh precision photometry of their parent stars. It will provide the targets to the future ground (e.g. E-ELT) and space-based (e.g. JWST) facilities, that will be used to characterize the exoplanet atmospheres. CHEOPS is a joint ESA-Switzerland mission, with important contributions from Italy and other ESA member states. Funded by ASI, the italian contribution to the payload is the integration and testing of the telescope, whith the optical parts designed and produced in Italy, the preparation of the scientific program and the realization of the mirror archive for the scientific data. CHEOPS in Italy is made by the collaborative efforts of INAF (Catania and Padua), University of Padua, and ASI.

COrE++

COrE++ is a medium-class space mission aimed at a precision measurement of the B-modes in CMB polarization produced by the cosmological inflation process.

COrE++ (Cosmic Origins Explorer ++) is a medium-class mission, able to carry out the final measurement of the cosmological B-mode signal in CMB polarization. The telescope (1.5m class) is passively cooled, and feeds a wide focal plane including >2000 polarization sensitive detectors operating at 0.1K and covering >15 bands in the 60 to 600 GHz range.
Working in L2, such a mission can measure accurately the cosmological B-modes signal, extracting it from overwhelming polarized foregrounds and lensing B-modes. The target sensivivity for the tensor to scalar ratio is 4x10-4 at 68% C.L.. COrE++ will be submitted for the M5 call, and inherits the activities carried out for the previous ESA calls (B-pol, COrE, PRISM, COrE+).

CoRoT

CoRoT was a space mission devoted to the study of the variability with time of stars brightness, with an extremely high accuracy (100 times better than from the ground), for very long durations (up to 150 days) and with a very high duty cycle (more than 90%).

The CoRoT (COnvection, ROtation and planetary Transits) satellite was devoted to the study of stellar interiors through the asteroseismology and to the discovery of new planetary systems with the transit method. Launched on December 27th, 2006, CoRoT observed 171 bright (V<9.5 mag) and nearby stars in the asteroseismic channel and about 160,000 faint (V>10.5 mag) in the exoplanetary channel. Operations ended in November 2012 after a second dramatic failure. In asteroseismology, CoRoT pionereed the systematic detection of solar-like oscillations in cool star, similar to our Sun, and in red giants, opening the possibility to perform galactic archaelogy. CoRoT also discovered the first terrestial size, rocky planet CoRoT 7b. The continuous observations up to 150 days allowed the refinement of our knowledge in several classes of variable stars, like Cepheids, RR Lyr, and pulsating variables in binaries. After several preparatory works in different domains, the Italian scientific community (Milan, Catania, Rome, Naples, Palermo) was responsible of the ground-based spectroscopic observations for the asteroseismic program. Three consecutive Large Programmes were approved by ESO (one with FEROS at the 2.2m MPI telescope, two with HARPS at the 3.6m ESO telescope), thus observing the targets simultaneously in photomtetry from space and in spectroscopy from ground. Moreover, several programs based on the Additional Science were led by Italian Scientists (RR Lyr and Cepheid variables, pulsating stars in binaries, rotational variables).

DAMPE

In a sun-synchronous orbit at the altitude of 500 km. Scientific payload: a space telescope for high energy gamma-rays, electrons and cosmic rays detection.

The main scientific objective of DAMPE (Dark Matter Particle Explorer) is to measure electrons and photons with much higher energy resolution and reach than currently achievable, in order to identify possible Dark Matter signatures. DAMPE is composed by a double layer plastic scintillator, a silicon-tungsten tracker-converter (STK), made of 6 tracking double layers of silicon strip detectors with three layers of Tungsten plates for photon conversion, and an imaging calorimeter (BGO) of about 31 radiation lengths thickness, made up of 14 layers of Bismuth Germanium Oxide bars in a hodoscopic arrangement. The Italian contribution, under the leadership of the Italian National Institute for Nuclear Physics (INFN-Perugia), has been in the design and construction of the STK, and is currently focused on the detector calibration and data analysis.

Euclid

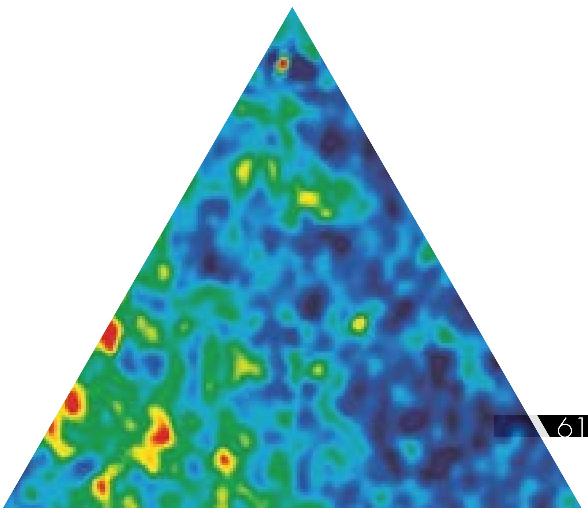
M2 ESA mission devoted to map dark content of the universe using two complementary cosmological probes: galaxy clustering and gravitational weak lensing.

Euclid will investigate the evolution of the universe during the last 10 billion years, by accurately tracking gravitational effects on expansion rate and cosmic structure growth. Tiny distortions, induced on galaxies shape by the presence of Dark Matter alo ng the line of sight, will allow gravitational field to be reconstructed with 3-D maps. Baryonic Acoustic Oscillations and redshift-space distortions, derived from the spatial distribution of galaxies as a function of redshift (i.e. of universe time evolution), will be used to study universe expansion rate. This is supposed to be governed by Dark Energy, which represents almost 75% of the matter-energy content of the universe today. Euclid, to be launched in 2020 to an L2 orbit, will observe more than 15000 square degrees of extragalactic sky in a 6 year long mission. The Euclid Consortium is composed of more than 120 institutes from 14 European countries, with the participation of NASA. Italy is leading the Science Ground Segment and it is procuring instrument control and data processing units, HW and SW, for both instruments and an on-board opto-mechanical element (Grism Wheel). Italian scientists contribute to several scientific activities and two of them are members of the ESA Euclid Science Team.

Fermi

Fermi observes the cosmos using the highest-energy form of light. Mapping the entire sky every three hours, Fermi provides an important window into the most extreme phenomena of the universe, from gamma-ray bursts and black-hole jets to pulsars, supernova remnants and the origin of cosmic rays.

The Fermi (Gamma-ray Space Telescope) mission was launched on June 11, 2008 by a Delta II rocket. Fermi is a NASA mission with a wide international collaboration from Italy, Japan, France, Germany and Sweden. The scientific payload is composed of the Large Area Telescope (LAT), operating in the 20 MeV - >300 GeV energy range, and the Gamma-ray Burst Monitor (GBM), operating in the 10 keV - 25 MeV energy range. Fermi is operating in sky survey mode and the LAT observes the entire sky every 3 hours, providing uniform exposure on the timescale of days. The high sensitivity and nearly uniform sky coverage of the LAT make it a powerful tool to investigate the properties of all high-energy astrophysical sources. The Fermi LAT First Source Catalog lists 1451 sources detected during the first 11 months of operation by the LAT, 56 of which are identified as pulsating neutron stars while about 700 are associated to active galaxies. The Italian participation encompasses several contributions starting with the design, construction and calibration of the LAT tracker, performed under Italian National Institute for Nuclear Physics (INFN) responsibility. Additional tasks such as software development, management of the Italian data archive mirror as well as scientific data analysis are jointly performed by INAF, INFN and ASI/ASDC.

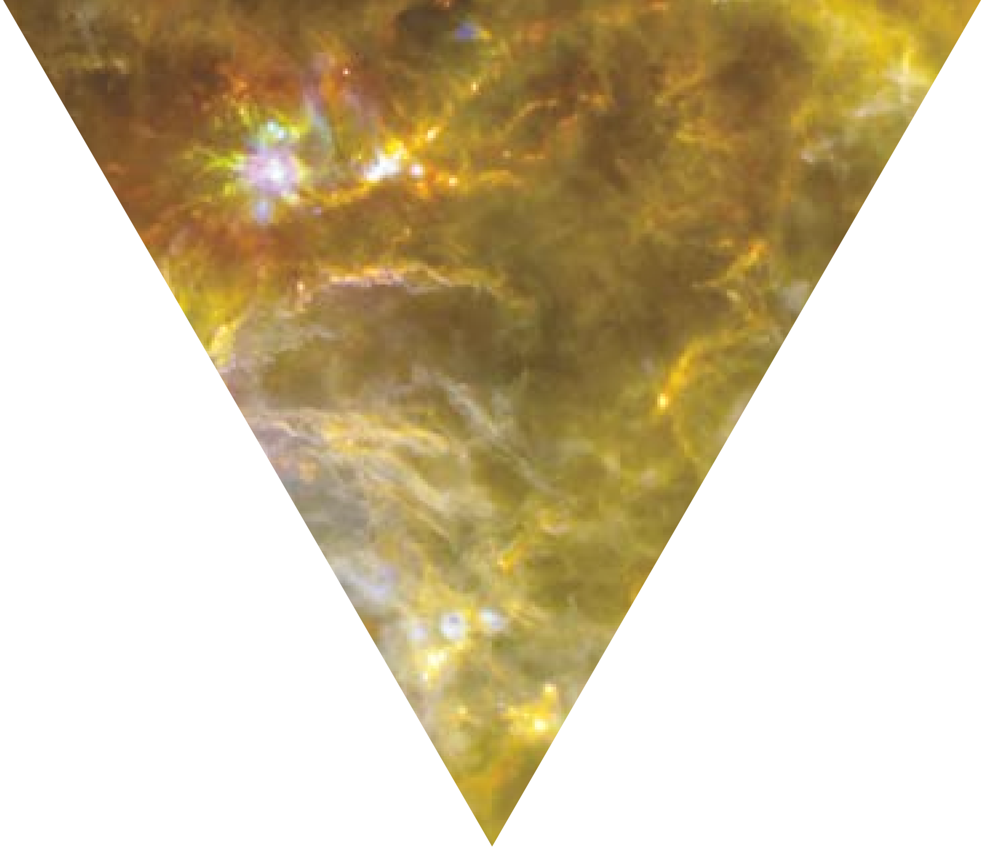


Gaia

The ESA cornerstone mission Gaia will provide a stereoscopic census of over a billion stars in our Galaxy and beyond. The positions, proper motions, radial velocities and astrophysical parameters will unravel the composition, formation, evolution and the history, both chemical as dynamical, of our Galaxy.

Gaia is a major project for the European astronomical community which will deeply change our view of the Galaxy with a precise and detailed stereoscopic survey of the billion brightest celestial objects (down to V magnitude 20). Gaia was launched in December 2013 and started its 5 years all-sky scanning survey. Gaia very high-accuracy global astrometry will allow to measure the 3D position of a star and its movement across the sky. Gaia will also gather spectroscopic data, allowing the determination of the radial velocities for several millions of galactic stars, and spectrophotometric data, measuring the astrophysical properties including luminosity, surface gravity, temperature and chemical composition. The predicted end-of-mission parallax standard errors are of the order of 9-25 µas at V=15 depending on the star color, this will provide a 10% error on distances at 10 kpc. The scientific data processing is a responsibility of the Gaia Data Processing and Analysis Consortium (DPAC), an european consortium of ~450 scientists.

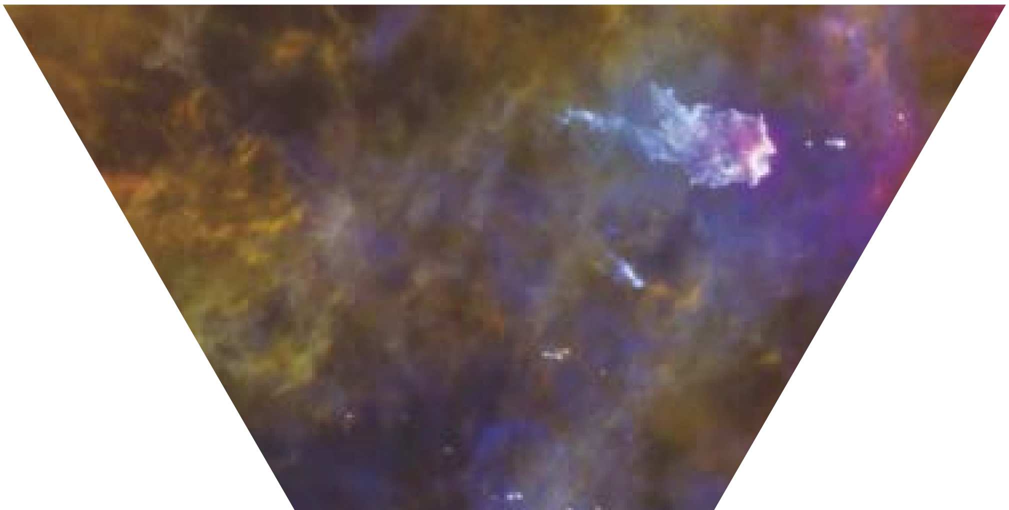
Italy deep involvement in DPAC activities includes contributions to astrometric verification, spectrophotometric data reduction and absolute calibration, variable and special object treatment, sources classification and cross-match with external catalogues. Italy is contributing with one of the six data processing centers and provides one of the four partner data center dedicated to Gaia data access and distribution which will support the scientific data exploitation by the national community. The first Gaia Release is foreseen by summer 2016.

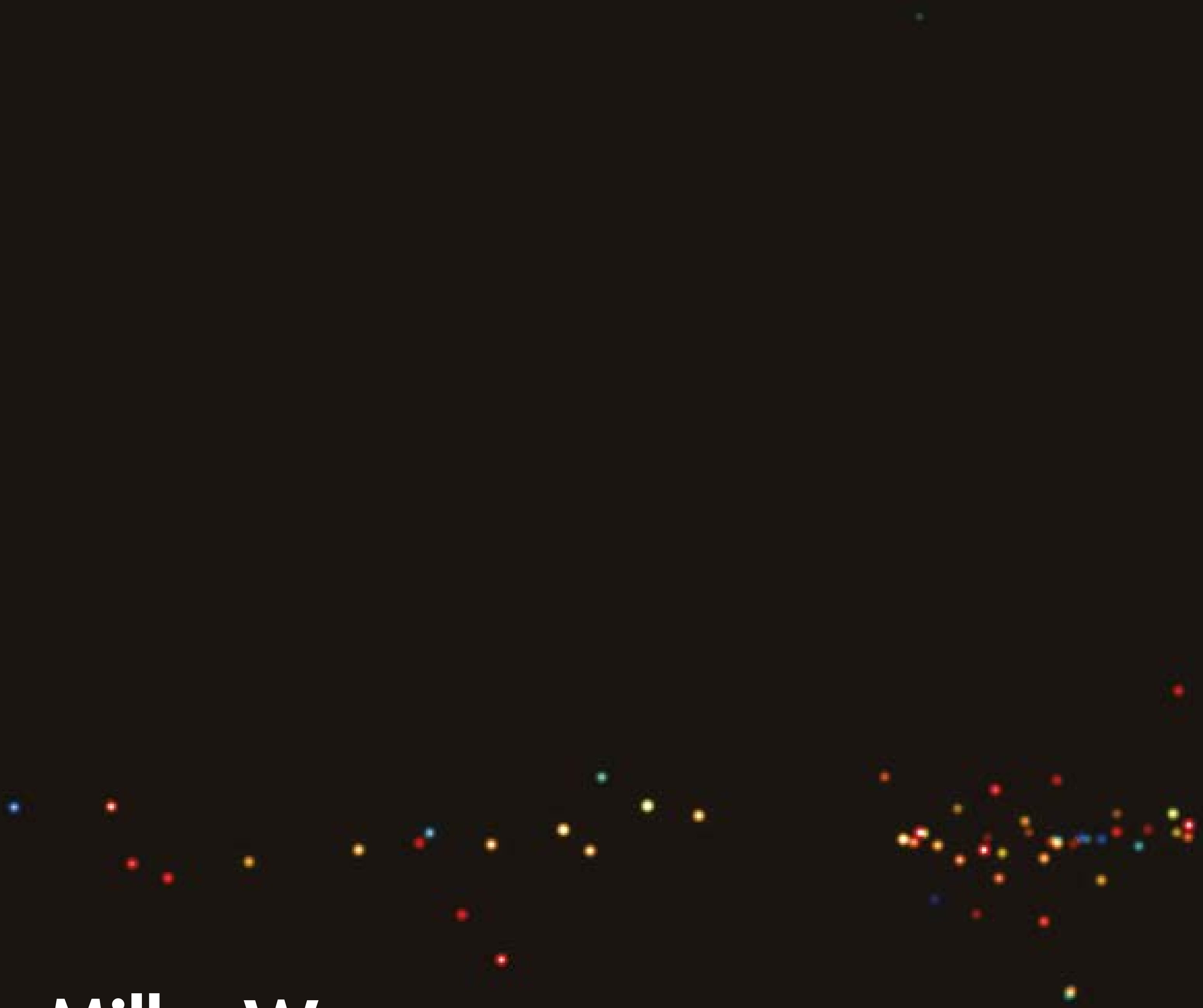


HERSCHEL

A new window to study how the universe has evolved to become the universe we see today, and how our star the sun, our planet the earth, and we ourselves fit in.

Herschel is a cornerstone mission in the ESA science programme, dedicated to far infrared and submillimeter astronomical observations between 60-670μm. It was conceived as a Space Observatory open to the entire astronomical community and it was the largest infrared space observatory launched so far. It is now decommissioned due to end of cryogenics life.

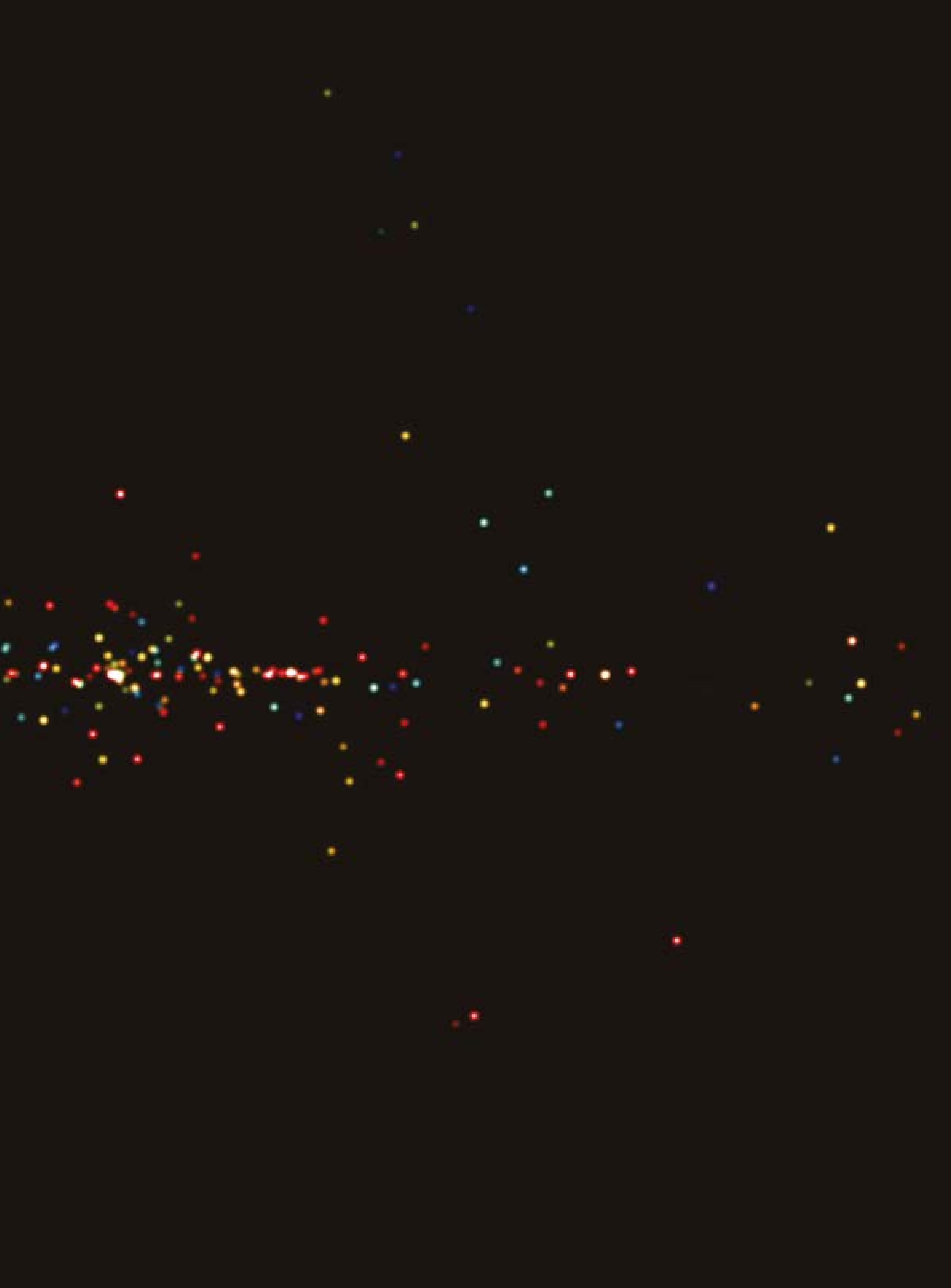




Milky Way

The entire sky seen by INTEGRAL.

Based on the unique combination of its instruments, INTEGRAL has been providing astronomers with a new view of the entire sky in hard X-rays and soft gamma rays for almost 14 years. By revealing both the diffuse emission from our Galaxy, the Milky Way, and the population of individual sources that shine brightly at these energies, INTEGRAL has broadened our understanding of several classes of sources, galactic and extragalactic alike.



HST

HST is the most popular NASA/ESA joint mission, and has made some of the most dramatic discoveries in the history of astronomy.

Launched in 1990, Hubble Space Telescope has been serviced several times by the space shuttle, allowing repair and substitution of its instruments, and it is still working at its best. Its expected life is planned to last several more years, with significant overlap with JWST operations. Its current instruments are ACS, COS, STIS and WFC3. Italy has officially contributed to the development of its first instruments. Italians are among the major users of HST.

INTEGRAL

ESA mission launched on 2002, is still operating with the same instrument performances following an Observing Scientific Program selected on a yearly call to the community. Italy participated with IBIS and to minor extent to SPI and Jem-X. ASI and INAF support operation, calibration and scientific data analysis.

The ESA INTEGRAL mission was approved as the 2nd medium size ESA project of the Horizon 2000 Scientific Program in April 1993 and successfully launched from Baikonur (Kazakhstan) on 17 October, 2002. INTEGRAL is an observatory type mission and its science payload is designed for the imaging and spectroscopy of persistent and transient cosmic sources in the 10-10000 keV band. There are two main instruments detecting gamma rays: the imager (IBIS) gives the sharpest gamma-ray images yet seen from astronomical targets; meanwhile the spectrometer (SPI) precisely measures Gamma-ray energies. The program is led by ESA, with the instrument complement and the Scientific Data Centre (based in Geneva) provided by five different European consortia with a large contribution from ASI and INAF Institutes (IAPS, IASF Milan, Bologna and Palermo) especially for IBIS and to a minor extent for SPI and Jem-X. Contributions were also provided by Russia, for the Proton launcher, and by the USA which made available a NASA ground station.

Besides the two main instruments INTEGRAL offers substantial monitoring capability in the X-ray range, from 3 to 30 keV, and in the optical V band at 550 nm. In view of the impossibility of focusing high energy X-rays and soft gamma-rays, the three high energy instruments are operated with a coded mask to provide good imaging capability over a wide field of view. This technique is a key feature of INTEGRAL to provide simultaneous images of the whole field observed and detection and location of all the sources. INTEGRAL provides almost an order of magnitude improved performance in spectroscopy and imaging compared to earlier high energy observatories. After more than 13 years of operation, INTEGRAL has detected more than 1000 high energy emitters: compact objects in binary systems, galactic and extragalactic black holes, pulsars, cataclysmic variables and many transient sources which shine once in a while in the sky.

Most of the INTEGRAL sources are new detections at these high energies and a good fraction of them still remain of unknown nature. Because of the high quality scientific results the operative life of the mission has been extended at least up to the end of 2016 with an extension till 2018 under ESA decision. The most recent results are the detection of the ^{56}Ni and ^{56}Co decay gamma-ray line of the type Ia SN2014J and the detection of a possible transient line at 511 keV in V404 Cyg. It also provided for the first time stringent upper limit on direct gamma-ray from the merger of the two Black Holes named GW150914, from which Gravitational Waves has been detected for the first time by the LIGO/VIRGO experiment.

JWST

The James Webb Space Telescope is an infrared telescope with a 6.5-meter primary mirror to be launched in October 2018. It will be the premier observatory of the next decade, serving thousands of astronomers worldwide.

JWST will be equipped with 4 instruments: the Near-Infrared Camera, provided by the University of Arizona, NIRSpec, provided by ESA with components provided by NASA/GSFC, MIRI, provided by a European Consortium with ESA and by JPL, and FGS/NIRISS, provided by CSA. With its four main science themes, 1) First Light and Reionization, 2) Assembly of Galaxies, 3) Birth of Stars and Proto-planetary Systems, 4) Planets and Origins of Life, JWST will study every phase in the history of our Universe. Unfortunately, Italy is not officially contributing to JWST, as a consequence of a decision by ASI many years ago. Italians are participating to the mission, either as ESA members or because of their individual role in international consortia and committees. Official steps to let Italy officially contribute to the mission would be highly desirable.

LSPE

The LSPE is a mm-wave polarimeter aboard of a stratospheric balloon, aimed at measuring the polarization of the Cosmic Microwave Background at large angular scales during a long duration flight in the Arctic winter.

Gravitational waves produced during inflation, a split-second after the big-bang, induce linear polarization in the CMB (both E-modes and B-modes). The signal from B-modes is extremely small, <0.1 mK rms and is mainly at large angular scales. LSPE targets are the reionization bump and the recombination bump in the angular power spectrum of B-modes. The LSPE has two polarimeters: SWIPE (with multi-mode bolometers and a rotating HWP) and STRIP (with coherent radiometers) covering the 40-250 GHz range with 5 channels, with an angular resolution of 1.3 deg FWHM and a combined sensitivity of 20 mK arcmin per flight. It is funded by ASI and Italian National Institute for Nuclear Physics (INFN) in Italy.

NuStar

The NuSTAR mission is the first hard X-ray focusing telescope to orbit Earth. It complements other missions such as XMM, Chandra, INTEGRAL and Swift exploring the energetic Universe.

The NuSTAR mission is a NASA Explorer launched in 2012: is the first hard X-ray focusing satellite. Primary objectives include: the census of black hole and stellar compact objects at different scales; the study of relativistic jets in the most active galaxies; the map of radioactive material in Supernova remnants to understand the explosion and nucleosynthesis mechanisms. It can efficiently work in synergy with other X-ray missions as well as Spitzer and HST. The Italian contribution includes: the provision of ASI ground station in Malindi (Kenya), data reduction software support and archival storage at the ASI Science Data Center (ASDC), contribution to the project with a team of INAF scientists that collaborates to the primary scientific mission goals.

OLIMPO

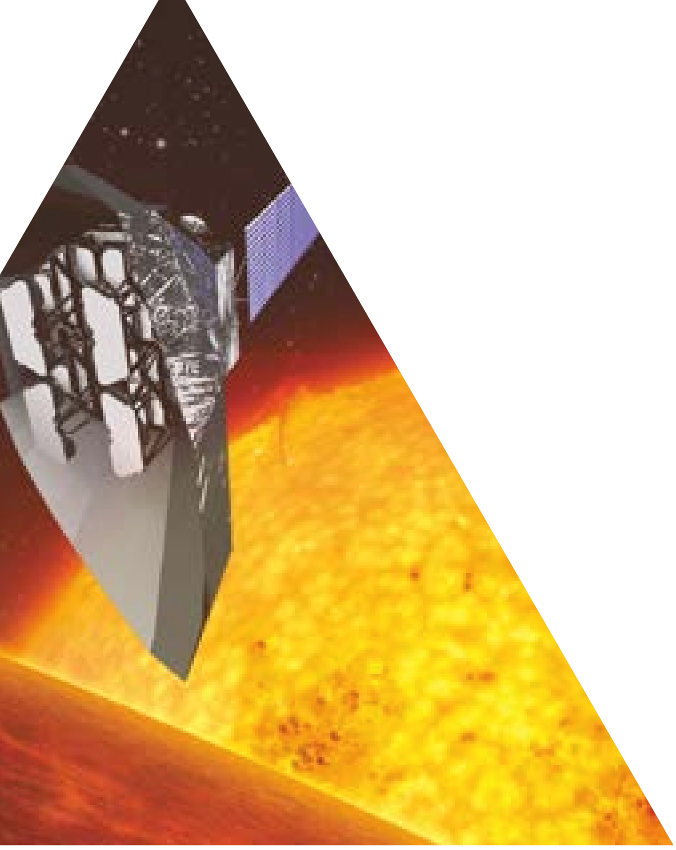
OLIMPO is a balloon-borne, 2.6m aperture telescope measuring the anisotropy of the mm/submm sky and its spectrum. It will be flown with a long duration circumpolar flight in the Arctic.

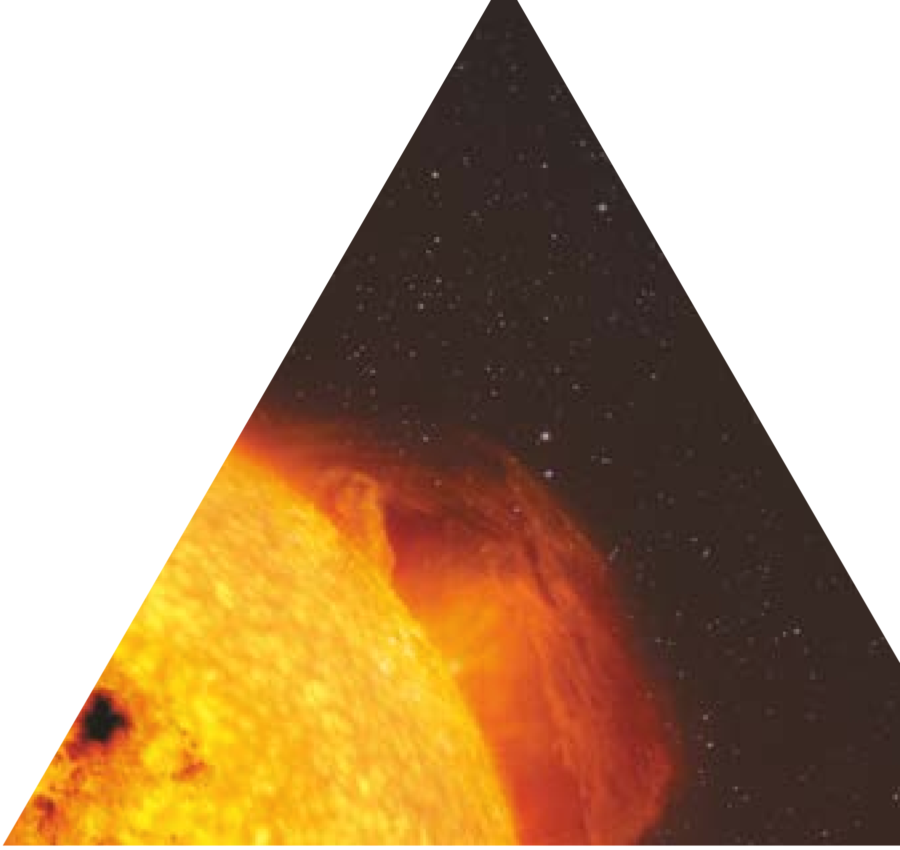
OLIMPO is a balloon-borne telescope for the measurement of the Cosmic Microwave Background and Cosmic Infrared Background anisotropy, with arcmin resolution. The instrument uses a Differential Fourier Transform Spectrometer (DFTS) and 4 cryogenic detector arrays to obtain spectral capabilities within 4 wide bands around 140, 220, 340, 480 GHz. The DFTS rejects the common-mode signal with high efficiency, extracting tiny spectral anisotropies from an overwhelming background. In a long-duration flight organized by ASI from Svalbard islands, the instrument will map >100 sky areas, including clusters of galaxies (spectroscopic study of the SZ), and blank areas (spectral-spatial anisotropy).

PAMELA

A satellite-borne experiment designed to study the charged component of the cosmic radiation, with particular emphasis on antiparticles. PAMELA consists of a magnetic spectrometer, an electromagnetic calorimeter, a time-of-flight system, an anticoincidence system, a shower tail catcher scintillator and a neutron detector.

It was the 15th of June of 2006 when the PAMELA satellite-borne experiment was launched from the Baikonur cosmodrome in Kazakhstan. Since then, PAMELA (Payload for Antimatter Matter and Light-nuclei Astrophysics) has been making high-precision measurements of the charged component of the cosmic radiation opening a new era of precision studies in cosmic rays. The measured antiparticle component of the cosmic radiation shows features that can be interpreted in terms of dark matter annihilation or pulsar contribution. The measurements of the energy spectra of protons, electrons, helium and light nuclei and their isotopes challenge our basic vision of the mechanisms of production, acceleration and propagation of cosmic rays in the galaxy. The study of the ten-year time dependence of the various components of the cosmic radiations clearly shows solar modulation effects as well as charge sign dependence. PAMELA measurement of the energy spectra during solar energetic particle events fills the existing energy gap between the highest energy particles measured in space and the ground-based domain. Finally, by sampling the particle radiation in different regions of the magnetosphere, PAMELA data provide a detailed study of the Earth magnetosphere.





Planck

A new map of the Cosmic Microwave Background anisotropies, covering almost the all sky, to provide a snapshot of the early Universe.

Planck is an ESA Cosmic Vision programme cryogenic mission dedicated to provide a map of the Cosmic Microwave Background anisotropies with improved sensitivities and angular resolution. The satellite was equipped with two sets of bolometers detectors. The LFI working in the range 27-77 GHz and the HFI working from 83 GHz up to 1 THz. It is now decommissioned due to end of cryogenics life.

PLATO

Selected by ESA for a 2024 launch, PLATO will search for planet transits and asteroseismological measurement of mass and age of hosting stars.

PLATO (PLAnet Transit and stellar Oscillations) is the next generation exoplanet finder, the third medium-class mission in ESA's Cosmic Vision programme.
In the current plans, PLATO will obtain light curves of up to one million bright dwarfs and subgiants, covering up to half of the sky, with almost continuous coverage for up to 3 years. Main purpose is the search for exoplanets, including rocky Earths and SuperEarths, and obtain seismic measurement of radii (~3% error), masses (~10% error), and ages (10% error) of hosting stars. PLATO will set the basis for the statistical study of exoplanet and exoplanet system bulk properties, their dependence on the environment, and how they evolve with age. PLATO is the necessary preparatory mission for target selection for following atmosphere studies.

SPICA

Observations in the mid and far infrared with sensitivity never reached to date, up to two orders of magnitude better than those of ESA Herschel's instruments.

SPICA (Space Infrared telescope for Cosmology and Astrophysics) is the natural successor to Herschel, with a more compact mirror with a 2.5m diameter, but more sensitive because actively cooled to <6K through cryocoolers, with the most technologically advanced instruments at the focal plane that will enable imaging and spectroscopy from the mid to the far infrared (12-230μm) to never reached sensitivity. The SPICA observations will allow the advancement of knowledge in different fields of astrophysics, the search for the first stars born in the universe through the detection of molecular hydrogen emission lines, the discovery of protoplanetary disks around stars, the study of early galaxies evolution, the interstellar medium and chemistry of gas and dust in the galaxy and in local galaxies, up to the spectroscopic study of extrasolar planets and those of the solar system. The European participation in the SPICA mission is lead by the SRON coordinating a consortium of European institutes, including the INAF-IAPS.

Swift

NASA mission with a strong contribution from Italy and UK. It is characterized by multiband good sensitivity and fast autonomous repointing.

Swift is a collaborative MIDEX NASA Mission with Italy and the UK. The Swift satellite, launched on November 2004, has onboard three instruments for the observation of the Gamma Ray Bursts (GRB): the Burst Alert Telescope (BAT), the X-Ray Telescope (XRT) and the Ultraviolet/Optical Telescope (UVOT). Swift detects ~90 GRBs a year and since its launch it revolutionized our knowledge of the field. The observing plan has evolved with time and now, although Swift continues to hunt for GRBs, the majority of the time is spent on target of opportunity (TOO) observations, covering all kind of sources, from comets to high redshift quasars. On average, four TOOs a day are performed. Thanks to its fast and autonomous repointing capability and good sensitivity in the X-ray and optical/UV bands, Swift is also heavily involved in the search of the electromagnetic counterparts of gravitational wave sources. Italy provides the ASI ground station in Malindi antenna for the uplink/downlink of the data, the Mirror Module of the XRT developed by the INAF-Astronomical Observatory of Brera under an ASI contract, the XRT data analysis software developed by the ASDC. Furthermore, the Italian team participate to the scientific management of the mission, funded by ASI.

XMM-Newton

Detail the physical conditions in the star forming regions and on the mechanisms acting for the production of X-rays in the magnetosphere of planets.

XMM-Newton was the second cornerstone of the Horizon 2000 program of the ESA. It was launched on December 10th, 1999 and it is still operating perfectly. Taking advantage of its high trough-put, spectral and timing capabilities, XMM-Newton allowed to collect probes of the theory of relativity in AGN and compact Galactic objects. AGN taxonomy and population across cosmic time has been studied using XMM-Newton to survey portions of the sky. It was also fundamental to study galaxy clusters and in particular to study their physics and the effects induced by the "dark matter". Finally, XMM-Newton has been successfully operated to detail the physical conditions in the star forming regions and on the mechanisms acting for the production of X- rays in the magnetosphere of planets. Thanks to the coordinated involvement of its research structures IASF-Milan, IASF-Bologna and INAF-Astronomical Observatory of Palermo is contributing to the realization of the three EPIC cameras. Moreover, INAF-Astronomical Observatory of Brera did significantly contribute, together with the MediaLario industry, to the realization of the large area mirror modules. The INAF Observatory of Palermo has been involved in the development and calibration of the EPIC optical filters. The mission shall operate up to at least 2014 with an extension till 2016 under ESA decision.

Puppis A

View from XMM-Newton and Chandra.

Since Earth's atmosphere blocks out all X-rays, only a telescope in space can detect and study celestial X-ray sources. The XMM-Newton mission is helping scientists to solve a number of cosmic mysteries, ranging from the enigmatic black holes to the origins of the Universe itself.

ABCDEFGHIJKL

Scientific Commission

ALTEA

Anomalous Long Term Effects in Astronauts' Central Nervous System (ALTEA) integrates several diagnostic technologies to measure the effect of the exposure of crewmembers to cosmic radiation.

ALTEA is an ASI program realized by the University of Rome Tor Vergata and Italian National Institute for Nuclear Physics (INFN) aimed to study the brain functional effects of the space radiation environment, with a focus on the Light Flashes phenomenon. The Mission ended in August 2007. In 2008 an agreement was signed with NASA to utilize this instrument as a detector for operational purposes. Thanks to this agreement ALTEA is today operative on board the ISS in DOSI mode. ALTEA is composed by six particle telescopes arranged in a helmet shaped support, a visual stimulator, an electroencephalograph, a pushbutton. It features two different main experimental protocols: unmanned one (DOSI) during which the detectors monitor the radiation environment with a real time data downlinking to ground, and a manned one (CNSM) during which the particles passing through the astronaut's head are measured, together with the astronaut brain electrophysiological dynamics, looking for correlations between particle passages and brain electrophysiology.

ELITE-S2

The human motion analysis facility for the International Space Station: technological characterisation and potential application for multifactorial movement analysis in microgravity.

Elaborator of Televised Images (ELITE-S2) is an instrument created for gathering and analysing data on man's movement in space. Its objective is to study the strategies and adaptive mechanisms that the central nervous system uses for motor control in the space environment. ELITE S2 is therefore a system centred on human neurophysiology with particular regard to the analysis of three- dimensional movement of man in space. It is based on an optoelectronic system for the quantitative analysis of human movement in three dimensions. The system can reconstruct the astronauts' movements, illuminating with four lasers up to one hundred markers placed on the body in subject, with accuracy less than a millimetre. Astronauts will repeatedly carry out two scientific protocols of the University of Rome Tor Vergata and Politecnico di Milano during that period. ELITE- S2 was brought on board the ISS in August 2007 with the STS 118 Mission. Five experimental sessions have been performed during 2008 and other are foreseen.

HPA

Hand Posture Analyzer (HPA) examines the way hand and arm muscles are used differently during grasping and reaching tasks in weightlessness (effects of long-duration space flight on muscle fatigue).

HPA is an ASI instrument developed for evaluating the impairment in performance of the muscular system and to select and define the strategies of movement of the upper arm under prolonged microgravity conditions. HPA has been used in five different missions for carrying out the three experiments selected that concern the area of motor control disturbances (IMAGINE experiment of the University of Rome Tor Vergata, the MAIS experiment of the Hospital Camaiore of Viareggio and the CHIRO experiment of the Hospital S. Chiara of Pisa). The experiments have been carried out during increment 7 of 2003 and 8 of 2004, respectively by American astronauts Ed Lu and Mike Foale. In 2005 it was part of the experiment programme during the "taxi flight" of Soyuz 10S with Italian astronaut Roberto Vittori. In 2007 it was used again during the Esperia mission with Italian astronaut Paolo Nespoli. Hand Posture Analyzer was on board the ISS in 2003. It will possibly be re-utilized to increase the data acquired so far (2010).

MDS

An ASI experiment that will use a validated mouse model to investigate the genetic mechanisms underlying bone mass loss and other microgravity effect on different tissues such as muscles, glands, brain.

Mice Drawer System (MDS) is an animal room where long-term experiments on small rodents can be performed on board the International Space Station, it has been launched on the STS 128 on August 29, 2010.

The idea for a MDS facility comes from a proposal by the Centro di Biotechnologie avanzate (Centre for Advanced Biotechnologies of Genoa) that aims at finding out about the genetic mechanisms that are the basis for the pathophysiology of bone mass. In addition to this experiment, another six experiments are scheduled regarding the study of the muscular, cardiac and endocrine systems. An international "tissue sharing" programme is also planned coordinated by ASI that involves the participation of selected experimenters from NASA, JAXA, ESA and DLR.

ABCDEFGHIJKL

Scientific Commission

AMS-02

A state-of-the-art particle physics detector designed to operate as an external module on the International Space Station. Goal: study the universe and its origin by searching for antimatter, dark matter while performing precision measurements of cosmic rays composition and flux.

The Alpha Magnetic Spectrometer (AMS-02) is a state-of-the-art particle physics detect designed to operate as an external module on the International Space Station. It uses the unique environment of space to study the universe and its origin by searching for antimatter, dark matter while performing precision measurements of cosmic rays composition and flux. AMS-02 will measure the rigidity and the sign of the cosmic rays particles with its magnetic spectrometer and will separate the electromagnetic from the nuclear part by means of multiple particle identification detectors. The energy of the electromagnetic component will be measured by a dedicated calorimeter. The scientific goals of the AMS-02 experiment include the search for antimatter nuclei, the search for dark matter signatures and the precise determination of the cosmic rays rare components flux. AMS-02 has been launched on the Space Shuttle Endeavour in 2011 and will operate on the International Space Station for at least ten years. The AMS-02 collaboration is an international group of scientists, from 16 countries and 3 continents, working together since 15 years. Italy institutes collaborating to AMS-02 are the Universities and the linked Italian National Institute for Nuclear Physics (INFN) units of Bologna, Milan, Pisa, Perugia, Rome and Siena. The Italian contribution is prominent in 4 out of 5 sub- detectors and covered also a significant part of the space qualification tests that have been performed at the SERMS test facility in Terni. In Italy AMS-02 is funded by ASI and INFN.

ARIEL

Candidate for the ESA M4 mission approved for the assessment phase. It is devoted to study a large number of Exoplanets with the transit spectroscopy technique in the spectral range from 2 to 8 microns. Once approved, the spacecraft will be launched on 2025, with nominal operations of about 3 years up to 2029.

ARIEL (Atmospheric Remote-sensing Infrared Exoplanet Large-survey) will observe a large number (~500) of warm and hot transiting gas giants, Neptunes and super-Earths around a range of host star types using transit spectroscopy in the ~2-8 μm spectral range and broad-band photometry in the optical. The planets hotter than 600K that ARIEL will observe, due to their well-mixed atmospheres which should show minimal condensation and sequestration of high-Z materials, will reveal their bulk and elemental composition (especially C, O, N, S, Si). Observations of these hot exoplanets will allow the understanding of the early stages of planetary and atmospheric formation during the nebular phase and the following few millions years. ARIEL will thus provide a truly representative picture of the chemical nature of the exoplanets and relate this directly to the type and chemical environment of the host star. For this ambitious scientific programme, ARIEL is designed as a dedicated survey mission for transit and eclipse spectroscopy, capable of observing a large and well-defined planet sample within its 3.5-year mission lifetime. The italian contribution to ARIEL is relevant, with a Co-PI ship of the mission and large contribution for the hardware of the Telescope, Electronics, Software, Ground Segment and part of the Spectrometer. The scientific and laboratory contribution is also relevant from various groups of different expertise.

BepiColombo

A general description is given in Commission B.

e-LISA

A constellation of three spacecrafts, milions of km apart, each containing Test Masses in free fall, whose distance is measured by lasere interferometry.

The Gravitational Universe is the theme of the ESA L3 mission (third Large mission of the century), now scheduled for 2034. The evolved Laser Interferometer Space Antenna observatory will detect and measure gravitational waves in the milliHertz region, gathering detailed information on astrophysical phenomena like merging of compact objects (including black holes, not accessible to e.m. observation), Extreme Mass Ratio Inspirals, galaxy coalescence and other events, virtually at any distance in universe. eLISA will consist of a constellation of three spacecrafts, milions of km apart, each containing Test Masses in free fall, whose distance is measured by lasere interferometry. Most of the "enabling technologies" are tested on a dedicated ESA mission, called LISA Pathfinder, at present operational and gathering data.

LARES

The LAser RElativity Satellite is a passive, laser ranged satellite. The mision's main goal is the measurement of the relativistic frame-dragging effect.

Italian small mission characterized by low cost and fast time of realization, LARES has been launched on February 13, 2012, with the qualification launch of VEGA. The relativistic measurement will be reached thanks to the very precise measurements of the satellite orbit provided by the Satellite Laser Ranging technique and through the scientific analysis of the acquired data combined with the ones given by the LAGEOS (NASA) and LAGEOS-2 (ASI/NASA) satellites. These two satellites have already contributed to measure the Earth gravitational with high precision and have provided a first measurement of the Lense-Thirring precession at a 10% level. The LARES mission has been a collaboration between ASI, Italian National Institute for Nuclear Physics (INFN), University of Rome, and University of Lecce.

LISA

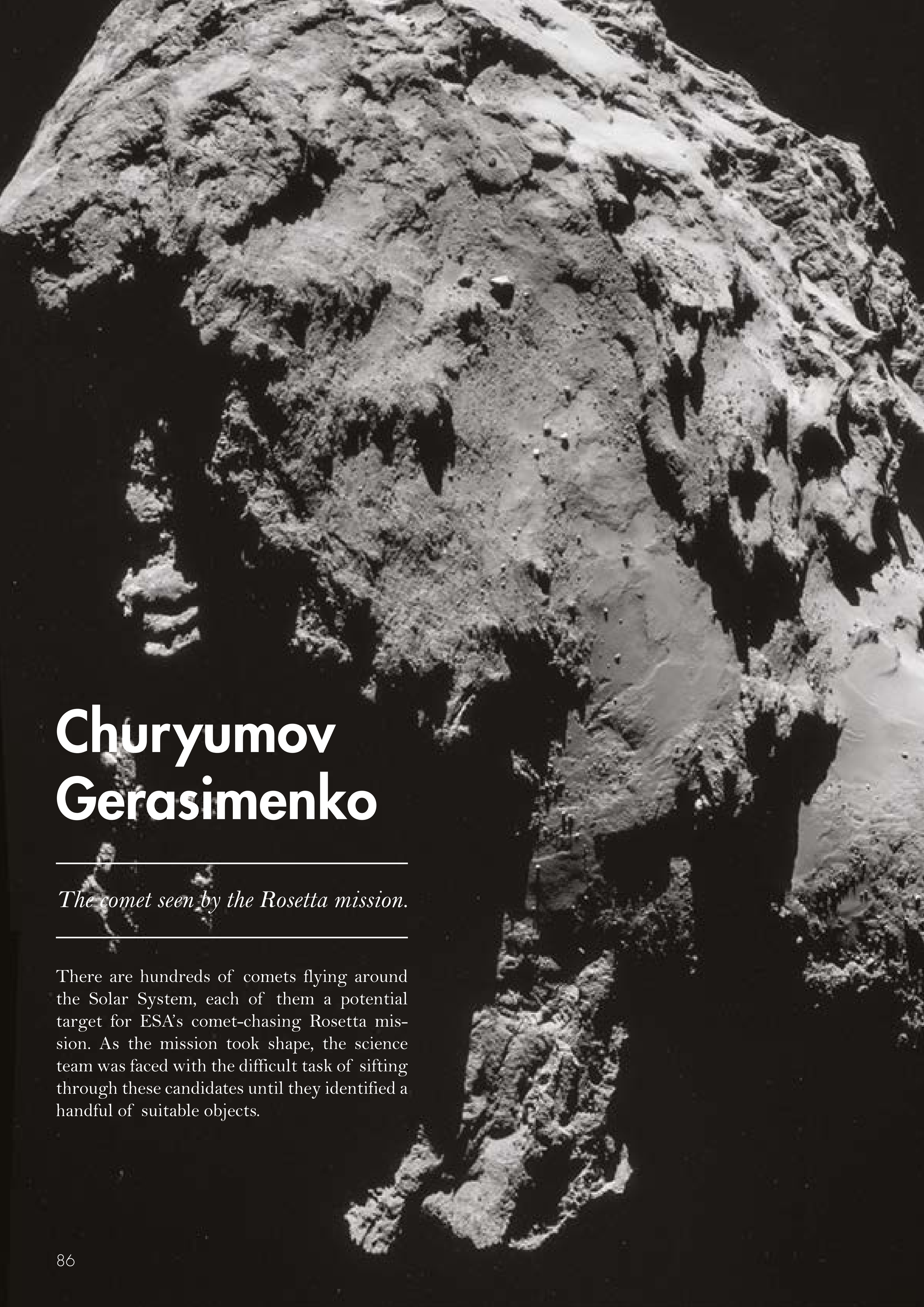
The aim of LISA-Pathfinder is to "in flight" validate the technologies needed for a space-borne gravitational wave detector.

Lisa-Pathfinder is an ESA space "precursor" mission that opens the way for the eLISA observatory.
Lisa-Pathfinder hosts two test masses in near-perfect gravitational free-fall and measures and controls their motion with unprecedented accuracy. This is achieved through state-of-the-art technology including the electrostatic inertial sensors, the laser metrology system, the drag-free control system and an ultraprecise micropropulsion system. Launched on Dec 3rd, 2015, LISA is orbiting around the L1 Lagrange Point and performing an exhaustive series of tests. The results have been so far exceptionally good, demonstrating the feasibility of space-borne interferometry and measuring a quality of free-fall with residual accelerations below the femto-g level.

GG

Galileo Galilei is small satellite to test the Equivalence Principle of Galileo, Newton and Einstein to 1 part in 10^{17} and beyond.

GG is a small satellite to be injected in low Earth orbit by the VEGA launcher with the goal of testing the Equivalence Principle of Galileo, Newton and Einstein to an unprecedented high precision of 10-17, and possibly better. Such a result would improve current best tests by more than 4 orders of magnitude and be of crucial importance for both Physics and Cosmology; evidence of a violation would represent a scientific revolution. The feasibility of GG has been confirmed by an ASI funded Phase A- 2 Study completed in 2009 and based on experimental results from the GGG (GG on the Ground) laboratory prototype. A collaboration has initiated in 2010 with NASA JPL which has recently expressed to ASI its interest to collaborate in GG seeking appropriate NASA funding opportunities.



Churyumov Gerasimenko

The comet seen by the Rosetta mission.

There are hundreds of comets flying around the Solar System, each of them a potential target for ESA's comet-chasing Rosetta mission. As the mission took shape, the science team was faced with the difficult task of sifting through these candidates until they identified a handful of suitable objects.

87

Sitography

URL

For further information please visit our websites.

AGILE
www.asi.it/en/flash_ en/exploring/agile
agile.rm.iasf.cnr.it

ALTEA
www.nasa.gov/mission_pages/station/science/experiments/ALTEA.html
www.asi.it/en/activity/medicine/iss_scientific_payloads

AMS-02
www.ams02.org/it
ams.pg.infn.it/ams-italy
www.asi.it/en/activity/high_energy/ams

ARIEL
www.ariel-spacemission.eu

ASPIICS
www.esa.int/Our_Activities/Space_Engineering_Technology/Proba_Missions/About_Proba-3

ASTROSAT
astrosat.iucaa.in
www.brera.inaf.it/utenti/belloni/GHATS_Package/Home.html

ATHENA
www.the-athena-x-ray-observatory.eu

BepiColombo
www.cosmos.esa.int/web/bepicolombo/home
www.asi.it/it/attivita/sistema_solare/bepi_colombo
www.iaps.inaf.it
www.maps.oapd.inaf.it
www.oacn.inaf.it/oacweb/oacweb_ricerca/cosmici/space_technologies.php?var=1&&id=1&&tit=1&&team=1

CALET
calet.pi.infn.it

Cassini-Huygens
saturn.jpl.nasa.gov
www.asi.it/it/attivita/sistema_solare/cassinihuygens
www.iaps.inaf.it/vims

CHEOPS
www.oact.inaf.it/cheops-it
sci.esa.int/cheops
cheops.unibe.ch

Chandra
www.nasa.gov/mission_pages/chandra
www.astropa.unipa.it/progetti_ricerca/indiceprog.html

CLUSTER
sci.esa.int/cluster

CORE++
www.b-pol.org
www.core-mission.org
www.prism-mission.org

COSMO SkyMed
www.asi.it/en/activity/observation-earth/cosmo-skymed
www.e-geos.it/cosmo-skymed.html

CoRoT
corot.cnes.fr

CSES-Limadou
cses.roma2.infn.it/
www.iaps.inaf.it/downloads/2016-I-NAF-IAPS-PlasmaChamb

DAMPE
dpnc.unige.ch/dampe

DAWN
dawn.jpl.nasa.gov
www.asi.it/it/attivita/sistema_solare/dawn
www.iaps.inaf.it/vir

DUSTER
dsa.uniparthenope.it/duster
www.oacn.inaf.it/oacweb/oacweb_ricerca/cosmici/sistema_solare.php?var=14&&id=1&&tit=14&&team=14

e-LISA
https://www.elisascience.org

ELITE-S2
www.asi.it/en/activity/medicine/iss_scientific_payloads

Euclid
www.euclid-ec.org
sci.esa.int/euclid
www.nasa.gov/mission_pages/euclid

ExoMars
exploration.esa.int/mars/46048-programme-overview
www.asi.it/it/attivita/sistema_solare/exomars

Fermi
fermi.gsfc.nasa.gov
www.asi.it/it/attivita/astrofisica/fermiglast
glast.pi.infn.it
www.iasf-milano.inaf.it/Divulgazione/divulgazione.php?pg=glast_fermi&mn=glast&lin=glast _fermi

Gaia
www.cosmos.esa.int/web/gaia
www.asi.it/it/attivita/cosmologia/gaia
gaia.asdc.asi.it
www.oato.inaf.it/astrometry/Gaia_Italia

GG
eotvos.dm.unipi.it/ggproject.html
www.asi.it/it/attivita/cosmologia/galileo_galilei

GOCE
www.esa.int/Our_Activities/Observing_the_Earth/GOCE
www.goceitaly.asi.it/GoceIT/index.php?option=com_content&view=article&id=96&Itemid=107

HERSCHEL
herschel.esac.esa.int
herschel.asdc.asi.it
www.ifsi-roma.inaf.it/ifsi/index.php?categoryid=20
hi-gal.ifsi-roma.inaf.it/higal

Hinode
hinode.nao.ac.jp/index_e.shtml

HPA
www.asi.it/en/activity/medicine/iss_scientific_payloads

HST
www.spacetelescope.org

INTEGRAL
www.sciops.esa.int/index.php?projec=INTEGRAL&page=index
www.asi.it/it/attivita/astrofisica/integral
projects.iaps.inaf.it/ibis

JUICE
sci.esa.int/juice

JUNO
nasa.gov/mission_pages/juno
missionjuno.swri.edu
www.asi.it/it/attivita/sistema_solare

JWST
www.jwst.nasa.gov
sci.esa.int/jwst
www.stsci.edu/jwst

LARES
www.dii.unisalento.it/seo-start/page/home.index/seo-stop/index.php?
www.asi.it/en/activity/cosmology/lares

LISA
sci.esa.int/lisa-pathfinder/
www.asi.it/it/attivita/esplorare-lo-spazio/cosmologia-e-fisica-fondamentale/lisa-pathfinder

LSPE
planck.roma1.infn.it/lspe
www.asi.it/it/attivita/esplorare-lo-spazio/cosmologia-e-fisica-fondamentale/lspe

Mars Express
www.esa.int/Our_Activities/Space_Science/Mars_Express
sci.esa.int/mars-express
www.asi.it/it/attivita/esplorazione-del-sistema-solare/mars-express

MDS
www.asi.it/en/activity/medicine/iss_scientific_payloads

MRO
www.nasa.gov/mission_pages/MRO/main/index.html
mars.nasa.gov/mro
www.asi.it/it/attivita/esplorazione-del-sistema-solare/sharad

NuStar
nustar.asdc.asi.it
nustar.gsfc.nasa.gov

OLIMPO
planck.roma1.infn.it/olimpo

PAMELA
pamela.roma2.infn.it

Planck
sci.esa.int/planck

PLATO
sci.esa.int/plato
www.asi.it/en/activity/cosmology-and-fundamental-physics/plato
www.oact.inaf.it/plato/PPLC/Home.html
www.oact.inaf.it/plato/Plato-Italia/Home.html

PRISMA
www.asi.it/en/activity/observation-earth/prisma

Rosetta
www.asi.it/it/attivita/esplorazione-del-sistema-solare/rosetta
sci.esa.int/rosetta

SCORE
metis.oato.inaf.it/index.php/instrument/score

SOHO
www.esa.int/Our_Activities/Space_Science/SOHO_overview2
sohowww.nascom.nasa.gov
www.cfa.harvard.edu/uvcs

Solar Orbiter
sci.esa.int/solar-orbiter
metis.oato.inaf.it/index.php

SPICA
www.ir.isas.jaxa.jp/SPICA/SPICA_HP/index-en.html
sci.esa.int/spica/42281-summary
sci.esa.int/trs/56108-next-generation-cryogenic-cooled-infrared-telescope
spica.edpsciences.org

STEREO
www.nasa.gov/mission_pages/stereo

Swift
swift.gsfc.nasa.gov
swift.asdc.asi.it
www.swift.ac.uk

THOR
thor.irfu.se

XMM-Newton
xmm.esac.esa.int

Acknowledgments

The editor acknowledges the contribution of the following people.

Autors
Teresa Capria
Davide Coero Borga
Livia Giacomini

Contributors
Alberto Adriani
Giovanni Ambrosi
Ester Antonucci
Massimo Bassan
Roberto Battiston
Angela Bazzano
Tomaso Belloni
Bruna Bertucci
Roberto Bruno
Roberto Buonanno
Laura Candela
Fabrizio Capaccioni
Elisabetta Cavazzuti
Priscilla Cerroni
Ignazio Ciufolini
Giuseppe Consolini
Gabriele Cremonese
Paolo De Bernardis
Maria Cristina De Sanctis
Vincenzo Della Corte
Anna Di Giorgio
Piero Diego
Luigi Dini
Eleonora Ferroni
Fabrizio Fiore
Valerio Iafolla
David Lucchesi
Nazareno Mandolesi
Maria Federica Marcucci
Pier Simone Marrocchesi
Gabriele Mascetti
Sergio Molinari
Aldo Morselli
Lorenzo Natalucci
Anna Nobili
Roberto Orosei
Isabella Pagano
Pasquale Palumbo
Giuseppe Piccioni
Piergiorgio Picozza
Giampaolo Piotto
Luigi Piro
Ennio Poretti
Fabio Reale
Alessandra Scaffidi
Paolo Soffitta
Daniele Spadaro
Luigi Spinoglio
Gianpiero Tagliaferri
Marco Tavani
Monica Tosi
Luca Valenziano
Stefano Vitale
Luca Zappacosta
Marco Ziggiotti

Printed in July 2016.

AGILE/ALTEA/AMS-02/ARIEL
/ASPIICS/Astrosat/Athena/
BepiColombo/CALET
/Cassini-Huygens/Chandra/
CHEOPS/CLUSTER/COrE++
/CoRoT/COSMO Sky-Med/
CSES-Limadou/DAMPE/DAWN
/DUSTER/e-LISA/ELITE-02/
Euclid/ExoMars/Fermi/Gaia
/GG/GOCE/HERSCHEL/
Hinode/HPA/HST/INTEGRAL
/JUICE/JUNO/JWST/LARES/
LISA/LSPE/Mars Express/MDS
/MRO/NuStar/OLIMPO/
PAMELA/Planck/PLATO
/PRISMA/Rosetta/SCORE/
SOHO/Solar Orbiter/SPICA
/STEREO/Swift/THOR/
XMM-Newton

ISBN 978-88-98985-01-2