



ACCADEMIA NAZIONALE DEI LINCEI

INTERNATIONAL CONFERENCE

EARLY ITALIAN SPACE SCIENCE IN A EUROPEAN CONTEXT

19-20 OCTOBER 2026

ABSTRACT

Organizing Committee: Francesco BERRILLI (Chair, Linceo, University of Rome Tor Vergata), Paolo DE BERNARDIS (Linceo, University of Rome La Sapienza), Carlo DOGLIONI (Vicepresident of the Accademia Nazionale dei Lincei), Imma DONNARUMMA (ASI), Monica LAURENZA (INAF-IAPS), Francesca MATTEUCCI (Lincea, University of Trieste), Francesco PEGORARO (Linceo, Scuola Normale Superiore, Pisa), Raffaele REDA (University of Rome Tor Vergata), Roberta SPARVOLI (University of Rome Tor Vergata e INFN), Umberto VILLANTE (SWiCo, University of L'Aquila), Myrka ZAGO (University of Rome Tor Vergata).

PROGRAMME

In the mid-1950s, scientific interest shifted toward outer space, focusing on the innovative use of rockets and satellites for direct exploration. In Italy, driven by Edoardo Amaldi, space research split into two main branches: a technological branch led by Broglio, and a fundamental physics branch – focused primarily on cosmic rays and heliophysics – developed at the Institute of Physics of the University of Rome by pioneers such as Francesca Bachelet, Franco Mariani, Anna Maria Conforto, Alberto Egidi, Sergio Cantarano, and Guido Pizzella. Upon returning from the United States, several of these researchers established research units within the CNR (National Research Council) and later at the University of Rome Tor Vergata. Other key centers emerged in Bologna and Milan. Around the same time, the National Institute of Geophysics contributed through studies on the ionosphere and Earth's magnetic field. Nearly 70 years later, this history has positioned Italy as a major participant in international space projects, supported by a vast community of researchers.

The first part of the Conference, geared toward a broader audience, will highlight early Italian space research. The second part, dedicated to "Future Horizons in Space Research," will address 21st-century challenges and opportunities across academic, educational, and industrial sectors. "University Programs and Opportunities" will be explored, such as the UNIVERSEH project, which is focused on the space field. Lastly, "Space Research and Our World" will examine the impact of space exploration on society, technology, and daily life.

The conference will also commemorate the Lincean academicians F. Mariani and N. F. Ness, alongside a small exhibition featuring original technical drawings of components from the first Italian satellites.

The birth of interplanetary plasma research based on space missions

Umberto VILLANTE (SWICo, University of L'Aquila)

Agli albori delle ricerche in fisica dello spazio interplanetario (anni '60), in Italia vennero sviluppati, per iniziativa pionieristica di alcuni ricercatori, i primi progetti per strumentazione da montare a bordo di sonde interplanetarie (e magnetosferiche). Viene qui presentata una breve rassegna dei risultati ottenuti dalle prime sonde dedicate allo studio del vento solare e del campo magnetico interplanetario (CMI). Si farà riferimento, in particolare, alle osservazioni effettuate, negli anni '70, dalle sonde *Helios 1* ed *Helios 2* che, mediante un esperimento magnetico frutto di una collaborazione Italia/NASA, consentirono di determinare la struttura e l'organizzazione del CMI nel sistema solare interno, spingendosi fino a distanze eliocentriche di ≈ 0.29 . Si trattò di osservazioni fondamentali che, confrontate con le osservazioni di altre sonde, consentirono di interpretare la "organizzazione a settori unipolari" del CMI in termini di attraversamenti, da parte delle sonde, di un articolato "strato magnetico", corotante con il Sole e inclinato rispetto al suo piano equatoriale. Identificato tale strato (oggi definito "interplanetary current sheet"), anticipando di molti anni le osservazioni di *Ulysses*, fu anche possibile evidenziare, per la prima volta, la dipendenza latitudinale dei parametri del vento solare. Successivamente, le osservazioni degli *Helios*, gettandone le basi, hanno consentito lo sviluppo di importanti studi relativi alla turbolenza dello spazio interplanetario. In generale, i risultati ottenuti dalle sonde *Helios* nel sistema solare interno, insieme con quelli dei *Voyager* e altre sonde giunte a grande distanza eliocentrica, hanno consentito di definire le proprietà fisiche dell'intera eliosfera e sono oggi anche di riferimento per le missioni *Parker Solar Probe* e *Solar Orbiter*.

During the early days of interplanetary space physics research (the 1960s), the first designs for instruments to be mounted on interplanetary (and magnetospheric) probes were developed in Italy thanks to the pioneering initiative of several researchers. This paper presents a brief overview of the results obtained by the first probes dedicated to studying the solar wind and the interplanetary magnetic field (IMF). Particular attention is given to observations made in the 1970s by the Helios 1 and Helios 2 probes; through a magnetic experiment resulting from an Italian-NASA collaboration, these probes enabled the determination of the IMF's structure and organization in the inner solar system, reaching heliocentric distances as close as ≈ 0.29 AU. These fundamental observations—when compared with data from other probes—made it possible to interpret the IMF's "unipolar sector organization" as the crossing of a complex "magnetic layer", co-rotating with the Sun and tilted relative to its equatorial plane (now known as the "interplanetary current sheet"). Anticipating by many years observations by the Ulysses mission, it also became possible to highlight, for the first time, the latitudinal dependence of the solar wind parameters. Subsequently, the Helios observations allowed the development for significant studies on interplanetary space turbulence. Overall, the results obtained by the Helios probes in the inner solar system, together with those from the Voyagers and other probes at great heliocentric distances, have made it possible to define the physical properties of the entire heliosphere and continue to serve as a reference for the Parker Solar Probe and Solar Orbiter missions today.

Beyond the Atmosphere: The Amaldi School's Journey into Space Physics

Francesco BERRILLI (Linco, University of Rome Tor Vergata)

This talk traces the origin and evolution of Italian space physics research from its beginning in 1958 to the present day. Inspired by a crucial 1958 meeting involving Edoardo Amaldi, Italian space research split into two complementary paths: a technological program led by Luigi Broglio and a fundamental science effort rooted at the Physics Institute at the University of Rome. Beginning with stratospheric balloon experiments carrying Geiger counters in 1962, the Rome group, including Mariani, Egidi, and Cantarano, built international ties through fellowships at MIT and NASA Goddard, experience that would prove decisive for Italy's participation in major missions such as ESRO's HEOS-1 and NASA's Pioneer 7 and 8, and led to the founding of the CNR Space Plasma Laboratory in 1968. Following the group's move to the University of Rome Tor Vergata, more than four decades of research expanded into ground-based heliophysics, driving pioneering contributions to CCD-based instrumentation and Fabry-Perot interferometry (IPM at THEMIS, IBIS at the Dunn Solar Telescope and THEMIS) for studying the dynamics of the solar atmosphere. On the space side, the team's leadership extended from the NASA-ASI Tethered Satellite System (TSS) mission to the ADAHELI small-mission proposal, and now to SEE (Sun Cube OnE), a CubeSat mission launching in 2028 that will carry Italy's first onboard solar disk imager. Together, these threads illustrate how a small research group grown out of the Amaldi school shaped, and continues to shape, Italy's role in space and solar physics.

The Evolution of the SVIRCO Neutron Monitor in Italy: From Pioneering Station to Modern Data

Monica LAURENZA (INAF – Istituto di Astrfisica e Planetologia Spaziali, Roma)

The history of cosmic-ray physics in Italy is closely linked to the development of the SVIRCO (Studio Variazioni dell'Intensità dei Raggi COsmici) Neutron Monitor and the scientific contributions of the Rome research group.

This talk traces the evolution of SVIRCO station from its early beginnings to its present-day configuration, highlighting the Rome group's sustained scientific leadership in the field and the enduring scientific value of ground-based cosmic-ray measurements for heliophysics as well as their relevance to modern space weather applications.

Technological advances in instrumentation, data acquisition, and measurements quality have progressively enhanced the SVIRCO observational capabilities. Pioneering activities also included terrestrial latitude surveys from Rome to the Arctic, the intercalibration of European cosmic-ray stations, and naval latitude surveys to Antarctica. These campaigns advanced coordinated cosmic-ray observations and marked a major step forward in the investigation of cosmic-ray intensity variations as a function of geomagnetic latitude and heliospheric conditions.

Building on this legacy, the SVIRCO Observatory has evolved to meet modern cosmic-ray monitoring needs, while preserving its status as a scientific asset of inestimable national value. As an integral part of the worldwide neutron monitor network, it remains an essential observational facility. Its operation is crucial to maintaining long-term cosmic-ray records and ensuring the continuity of ground-based observations, which remain indispensable for heliophysics research and space weather monitoring and operations.

From Cosmic Rays to the echo of the Big Bang: Early Space Investigations in Fundamental Physics and Cosmology at Sapienza, Rome

Paolo DE BERNARDIS (Linco, University of Rome La Sapienza)

Le misure effettuate nello spazio rappresentano oggi uno strumento consolidato nella ricerca in fisica fondamentale, gravitazione, astrofisica e cosmologia. I primi studi condotti presso la Sapienza Università di Roma hanno contribuito in modo significativo alle fondamenta di questi metodi osservativi. Le misure di raggi cosmici effettuate negli anni '50 dal gruppo guidato da Edoardo Amaldi, utilizzando emulsioni nucleari fotografiche a bordo di palloni stratosferici, portarono a prime scoperte di particelle, incluse le tracce candidate dell'annichilazione di antiprotoni. I palloni stratosferici vennero utilizzati anche negli anni '80, dal gruppo guidato da Francesco Melchiorri, per studiare la Radiazione Cosmica di Fondo nelle Microonde (CMB). Queste missioni furono fondamentali nell'ottimizzazione dei ricevitori bolometrici e nel perfezionamento delle metodologie per telescopi su pallone per microonde. Sulla base di questi sviluppi, negli anni 2000 il gruppo della Sapienza ha contribuito alla missione a lunga durata su pallone

BOOMERanG, che ha prodotto la prima mappa risolta della CMB, dando inizio all'era della cosmologia di precisione. A questa è seguita la missione spaziale Planck, che ha realizzato mappe ad alta precisione dell'intero cielo della CMB in intensità e polarizzazione, insieme a stime accurate dei principali parametri cosmologici. Sulla scia di questi traguardi, la ricerca attuale sulla CMB è diventata un'impresa globale in cui i dettagli più fini della CMB vengono indagati attraverso nuovi progetti, che spaziano da esperimenti mirati — come il grande telescopio su pallone OLIMPO e il polarimetro LSPE — a grandi missioni spaziali internazionali come il satellite LiteBIRD.

Space-based measurements represent an established tool in fundamental physics, gravitation, astrophysics, and cosmology research today. Early studies at Sapienza University of Rome contributed significantly to the foundations of these observational methods. Cosmic-ray measurements carried out in the 1950s by a team led by Edoardo Amaldi, using photographic nuclear emulsions aboard stratospheric balloons, yielded early particle discoveries, including candidate antiproton annihilation tracks. Stratospheric balloons were also used by a team led by Francesco Melchiorri to study the Cosmic Microwave Background (CMB) in the 1980s. These missions were instrumental in optimizing bolometric microwave receivers and refining balloon-borne telescope methodologies. Building on these advances, the Sapienza team contributed in the 2000s to the long-duration balloon-borne BOOMERanG mission, which produced the first resolved map of the CMB and initiated the era of precision cosmology. This was followed by the Planck space mission, which produced high-precision full-sky maps of the CMB in intensity and polarization alongside precise estimates of key cosmological parameters. Expanding upon these achievements, current CMB research has become a global effort in which the finest details of the CMB are investigated through new projects, ranging from focused efforts like the large balloon-borne OLIMPO telescope and the LSPE polarimeter to major international space missions like the LiteBIRD satellite.

The Evolution of Discovery: How Istituto Plasma-Spazio paved the way to Space Investigation

Giuseppe CONSOLINI (INAF-Istituto di Astrofisica e Planetologia Spaziali, Roma)

The Laboratorio di Ricerca e Tecnologia per lo Studio del Plasma nello Spazio of the Consiglio Nazionale delle Ricerche (LPS-CNR), founded in 1960, represented one of the first Italian institutions devoted to the investigation of space physics. Later, in 1981, LPS-CNR changed its name, becoming the Istituto di Fisica dello Spazio Interplanetario (IFSI-CNR), which saw its researchers take part in numerous space missions over the years. In 2005, IFSI joined the Italian National Institute for Astrophysics (INAF), and in 2012, it merged with INAF-IASF to create the current Institute for Space Astrophysics and Planetology (INAF-IAPS). In this presentation, some of the most relevant contributions to space missions from the early 1980s to the early 2000s will be reviewed. Additionally, the legacy of these early periods on current space missions will be briefly discussed.

The INGV and the Birth of Space Science

Claudio CESARONI (INGV)

Questo intervento ripercorre quasi novant'anni di ricerca ionosferica all'Istituto Nazionale di Geofisica, oggi INGV, mostrando come lo studio dell'alta atmosfera sia stato una delle radici della scienza spaziale italiana. Il racconto parte dal segnale transatlantico ricevuto da Marconi nel 1901 e dalle prove sperimentali dell'esistenza della ionosfera ottenute nel 1924-25 da Appleton e Barnett e da Breit e Tuve. Nel 1932 Ivo Ranzi costruisce a Camerino un apparato di radiosondaggio ionosferico e nel 1936 osserva gli effetti di un'eclisse solare sulla ionosfera. Nello stesso anno Marconi fonda l'Istituto Nazionale di Geofisica, dove nel 1938 Ranzi e Bolle realizzano il primo apparato italiano per il radiosondaggio ionosferico. Nel dopoguerra le osservazioni di S. Alessio, a Roma, diventano sistematiche e contribuiscono all'Anno Geofisico Internazionale, mentre il modello di Dominici e Mariani sulla regione F fa da ponte verso la fisica della magnetosfera. Con il progetto San Marco di Luigi Broglio, il radiofaro a 20 MHz del primo satellite italiano (1964) misura il contenuto elettronico tra satellite e suolo, e la base di Malindi apre l'accesso alla ionosfera equatoriale. Si passa poi dalle ionosonde costruite in casa a quelle commerciali e di nuovo a uno strumento progettato in Italia, la AIS-INGV, fino alle reti GNSS e al monitoraggio dello space weather, oggi riuniti nel Centro Osservazioni Spaziali della Terra (COS) dell'INGV. Due cerchi si chiudono: nel 2023 INGV, ASI e Agenzia Spaziale del Kenya aprono a Malindi il primo

osservatorio ionosferico del Kenya (progetto NORISK) e nel 2025 i segnali GNSS ricevuti sulla Luna dall'esperimento LuGRE permettono di osservare per la prima volta ionosfera e plasmasfera dall'esterno. Gli strumenti sono cambiati, la domanda è rimasta la stessa: quanti elettroni ci sono tra noi e il cielo?

This talk traces almost ninety years of ionospheric research at the Istituto Nazionale di Geofisica, today INGV, and shows how the study of the upper atmosphere became one of the roots of Italian space science. The story begins with the transatlantic signal Marconi received in 1901 and with the experimental proof of the ionosphere obtained in 1924–25 by Appleton and Barnett and by Breit and Tuve. In 1932 Ivo Ranzi built an ionospheric sounder in Camerino, and in 1936 he observed the effects of a solar eclipse on the ionosphere. That same year Marconi founded the Istituto Nazionale di Geofisica, where in 1938 Ranzi and Bolle built the first Italian ionospheric sounder. After the war, soundings at S. Alessio in Rome became systematic and fed into the International Geophysical Year, while the Dominici–Mariani model of the F region provided a bridge to magnetospheric physics. With Luigi Broglio's San Marco project, the 20 MHz radio beacon on the first Italian satellite (1964) measured the electron content between satellite and ground, and the Malindi base opened access to the equatorial ionosphere. Instruments then moved from home-made to commercial ionosondes and back to an Italian design, the AIS-INGV, and on to GNSS networks and space-weather monitoring, now brought together in INGV's Center for Earth Observation from Space (COS). Two circles close: in 2023 INGV, ASI and the Kenya Space Agency opened Kenya's first ionospheric observatory at Malindi (the NORISK project), and in 2025 GNSS signals received on the Moon by the LuGRE experiment made it possible to observe the ionosphere and plasmasphere from outside for the first time. The instruments have changed; the question has not: how many electrons lie between us and the sky?

100-year of AeroSpace Engineering School

Fabio CURTI (University of Rome La Sapienza, University of Arizona, Tucson)

The School of Aerospace Engineering at Sapienza University of Rome has played a central role in the development of Italian space engineering. Established in 1926 as the School of Aeronautical Engineering, it is among the oldest academic institutions in the aerospace field. It adopted its current name in 1963 as its activities increasingly focused on astronautics. Its history connects the growth of aviation research with Italy's entry into the space age and the education of generations of engineers.

The San Marco Project grew out of this academic environment under Broglio's leadership. Approved by the Italian government in 1961 and supported by an agreement with NASA in 1962, the program pursued three main objectives: developing Italian scientific satellites, preparing Italian personnel for launch and orbital operations, and establishing an equatorial launch facility offshore near Malindi, Kenya.

The School later strengthened the connection between education and spacecraft development. In 1997, it launched UniSat, an educational program that gave students direct experience in designing and building microsatellites. By incorporating practical engineering projects into advanced training, the program connected academic study with the demands of spacecraft development.

Cosmic rays and space exploration

Roberta SPARVOLI (University of Rome Tor Vergata e INFN)

Cosmic rays are high-energy particles that constantly reach the Earth from the Sun, our Galaxy and the most energetic regions of the Universe. Their study provides a unique connection between astrophysics, particle physics and cosmology, offering insights into cosmic accelerators, particle propagation and fundamental questions such as the matter-antimatter asymmetry and the nature of dark matter.

Space exploration plays a crucial role in this research. Instruments operating on balloons, satellites and space stations can directly measure primary cosmic rays before they interact with the Earth's atmosphere. Missions over the last two decades have revealed unexpected features in the spectra of positrons, protons and atomic nuclei, challenging traditional models of cosmic-ray acceleration and transport. They have also set stringent limits on antinuclei and possible dark-matter signatures.

This talk will review how space-based cosmic-ray experiments explore the high-energy Universe, discuss their most significant results and present the scientific opportunities offered by future missions searching for antimatter, dark matter and the origin of cosmic rays.

The Space-It-Up Project: Strengthening Italy's Role in Space Science and Technology

Daniele BIANCHI (La Sapienza Università di Roma)

Space It Up! is a major Italian research initiative funded by the Italian Space Agency (ASI) and the Ministry of University and Research (MUR), aimed at strengthening national capabilities in space science and technology. Launched in 2024 with a total funding of €80 million over four years, the project brings together universities, research institutions, and industrial partners within a coordinated, multidisciplinary research network.

Research activities are organized into nine interconnected Spokes covering three main areas: fundamental knowledge and enabling technologies for space missions, Earth observation and environmental sustainability, and robotic and human exploration of extraterrestrial environments. Particular emphasis is placed on advancing scientific knowledge, developing innovative technologies, and fostering synergies across disciplines and institutions.

The presentation will provide an overview of the project's scientific objectives, research activities, and progress achieved during its first two years, highlighting selected results and the role of interdisciplinary collaboration. It will also discuss how Space It Up! contributes to consolidating Italy's space research ecosystem, supporting the next generation of researchers, and strengthening the country's role in future European and international space initiatives.

Growing the Space Talent Ecosystem: Connecting Education, Industry, and Society via the European University UNIVERSEH

Victoria BARABASH (Luleå University of Technology)

The international space market's requirements are evolving rapidly in response to global societal and technological trends. This development has generated growing demand for professionals who combine advanced disciplinary expertise with knowledge of modern working methods, higher-order thinking, engineering judgement, and problem-solving capabilities. Equally important are well-developed behavioural competences suited to international working environments. Meeting these requirements necessitates the continuous review and reconsideration of teaching and learning strategies and methodologies, thereby placing particular demands on the education sector.

These requirements can be addressed through the Competence Ecosystem that effectively integrates formal, informal and non-formal learning and promotes structural cooperation with the world of work. Student voice and student engagement in the Ecosystem's operational activities are crucial.

The European Space University for Earth and Humanity - UNIVERSEH <https://universeh.eu/> provides the institutional foundation for such an Ecosystem by bringing together seven universities from seven European countries that share a common vision and contribute complementary with expertise and resources. Established within the European Universities initiative, the alliance develops interdisciplinary education, research, innovation, and cooperation in the space domain for the benefit of students, professionals, and society. The University of Rome Tor Vergata plays an important role in this European collaboration, contributing its expertise in space science and technology, education, innovation, and knowledge transfer. As an active participant in Work Package 7, "Service to Society", the University of Rome Tor Vergata supports the development of the Competence Ecosystem by strengthening cooperation with external stakeholders and connecting academic learning with professional practice and broader societal needs.

The presentation reviews the strategies, good practices, and lessons learned from activities implemented and currently under development within the UNIVERSEH alliance and particularly within the Work Package 7 "Service to Society". It examines how structural and strategic cooperation among universities, academic institutions, public authorities, industry, and society can support the growth of a sustainable Space Talent Ecosystem. Attention is given to evaluating complementary educational approaches including formal education, interdisciplinary learning, practical training, international mobility, and industry collaboration for preparing professionals to address global challenges, contributing to the New Space agenda, and increasing awareness of and participation in space-related activities within the communities involved and beyond.

Exploring the Moon

Carlo ALBANESE (Telespazio)

Moon exploration is emerging as the next global strategic priority in space exploration with highly ambitious governmental and commercial missions over the coming decades for a permanent return of mankind to the Moon. Market analysts have recorded hundreds of planned missions to the Moon over the next decade. A dedicated satellite infrastructure around the Moon, providing communication and navigation services, will unlock the potential for future Lunar missions, enabling high-rate and low latency communications, this will allow embarking more science per mission as well as create opportunities for missions with smaller budgets. The presentation is focused on providing an overview of the context and the services that can be offered to anchor customers and commercial users to support the growth of the Lunar exploration. In Europe Telespazio is leading the development of such infrastructure to provide services to boost the Lunar Economy.